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Nevada's Gravel Highways

The great majority of the roads in the United States are of low-cost construction—earth, gravel, sand-clay, etc. Their condition depends largely upon intelligent and faithful maintenance, and therefore the maintenance of such roads should interest a greater number of highway officials than any other topic. We give in this issue descriptions of methods of maintaining low-cost roads in a number of states, extending from Nevada to South Carolina.

In the eleven western states 62½ percent of the paving program in 1925 consisted of low-cost road improvements, chiefly surfacing with gravel or selected material. In Nevada 90 percent of the construction is of this type.

In building her gravel roads Nevada's highway officials have born in mind that such a road may in a few years, with development of traffic, be used as the base for a higher type of surface. Consequently, the alignment, grade and drainage structures are planned and constructed so that only minor changes will be required in case a higher type of surface is placed at a later date.

Usually gravel surfaces are constructed of local material secured from deposits which have not been previously developed. A geological study of the country in the vicinity of a project

HIGHWAY ALONG WEST SIDE OF WALKER LAKE, A SCENIC ATTRACTION OF THE STATE.
Guards of native rock placed about ten feet apart and painted white, mark the edge of the road at night, although not much protection against leaving the road.

will usually indicate locations where surfacing materials may be found, even though the actual deposit does not appear on the surface. All deposits within a reasonable distance of the project are investigated and the extent of the deposit, character of material and cost of handling determined; and with this information a selection can be made of the deposit to be used on the project.

SURFACING MATERIAL

It is found that the surfacing material which gives the best results is composed of angular particles graded down from a maximum size of about 1 inch. An excess of material between one-half and one-eighth inch in size is advantageous but usually can not be obtained economically. The material passing the one-eighth inch screen should have distinct binding properties and should compose approximately one third of the mass; while the larger particles should be tough and durable to resist wear. But it is seldom that a deposit is found which consists of material fully meeting such a specification, and even by screening and crushing it is difficult to produce such a material from one deposit. If the screened fines consist of sand with little binding properties or of dust with none of the small gravel and grit required for stability, it is often possible to develop a source for binder in the vicinity of the project and mix this with the gravel on the road.

The difficulties of producing uniform material have been largely overcome in Nevada by a specification which requires the crushing of all material in the deposit between 6 inches and ¾ of an inch in size as measured on circular openings. The crusher is set to produce a material of one inch maximum size. The product of the crusher, together with the material which passes the¾-inch screen, is then run on a revolving or pitching screen with one-inch square or 1¼ inch circular openings. Rejects from this screen are returned to the crusher or wasted. Passing all material over ¾ of an inch in size through the crusher produces a greater percentage of ½-inch to ⅛-inch material than would be produced by crushing only the material above 1 inch in size. The percentage of material under ⅛ inch in size, that is, binder, is controlled by means of a ⅛-inch screen, the effective length of which can be regulated with adjustable plates. Excess fines are thus removed and wasted. The fine and coarse material is mixed and deposited in a bin from which it is loaded into trucks. If the bin is filled from a belt or bucket conveyor it is usually necessary to install a baffle board on the bin to prevent segregation of material.

Segregation must also be prevented in loading trucks. It may result from loading from a side spout which causes the coarser material to carry over to the far side of the truck; trucks are therefore best loaded from the bottom of the bin.

CONSTRUCTION OF SURFACE

Best results have been obtained in Nevada by constructing a gravel surface in layers not exceeding four inches in thickness. The Nevada specifications require that the material be hauled over the first course, since the hauling assists in compacting the material, but not over the top course. The surface of the first course

CRUSHING GRAVEL FOR NEVADA HIGHWAYS.

is maintained as uniform and even as possible while hauling is in progress, and all irregularities are removed and the depressions filled with gravel before the second course is placed.

End dump trucks which in the hands of an efficient driver practically spread the gravel while dumping have given the best results. If the gravel is dumped in piles, the entire mass must be moved in spreading; otherwise areas of unequal compaction occur and result in a rough riding road.

In a paper on this subject before the Association of Western Highway Officials (from which the information in this article was derived), Howard M. Loy, assistant state highway engineer of Nevada, said:

"For spreading the gravel and maintaining the surface during construction, a road grader does only a part of the work required. A float or drag should be used to secure and maintain a true and even surface until the gravel is well compacted.

"The percentage of fine material to be allowed will vary for different deposits and under varying conditions on the project. If the gravel is wet when hauled to the road, or watered immediately after dumping, the fines will hold up in the mass. If the gravel is dry the fines will often sift to the bottom, regardless of the percentage contained. If the subgrade material is fine soil some of this material will work into the gravel and appear as additional fines, but if the subgrade is hard there will be very little binder from this source. Also, the material placed near the deposit which receives more hauling, requires less binder than the material placed further away. It does not appear feasible under present methods to change the percentage of fines for each change in one of these variables. Practically the same results may be obtained by first determining the percentage required for average conditions and producing the material with this constant percentage and then, as the last step of the construction, adding additional binder to those sections of the road which appear deficient in this material.

"Watering the subgrade just previous to placing the gravel assists materially in preventing the soil from coming up into the surface, and also helps to prevent the formation of chuck holes during construction. Compacting of the surface is also accelerated by the addition of water as the gravel is being spread and by frequently sprinkling the entire surface. In Nevada five gallons of water per square yard of subgrade is sufficient, and an average of fifty gallons per cubic yard of surfacing material is required to secure satisfactory results. At this rate ten to fifteen thousand gallons of water must be supplied and hauled to the road each day.

"In many localities water is not available in such quantities, and the moisture necessary for thorough compaction must be supplied by rain or snow. In the more arid regions at least one winter season is necessary to compact the surface.

"If the surface is kept smooth and in proper shape by dragging while compacting, an even smooth riding surface will result."

MAINTENANCE

The methods employed in maintaining gravel roads in Nevada were described in another paper before the Association of Western Highway Officials by P. L. Boneysteele, maintenance engineer, as follows:

Patrol System.—The patrol system of maintenance has been found to be the most satisfactory system for the maintenance of gravel roads. Under this system a patrolman is placed in charge of a definite section of roadway and held

A WELL-MAINTAINED GRAVEL ROAD IN NEVADA.
Wooden guard rails on cedar or redwood posts at such height that the hub of a machine is at approximately the cen ter of the rail. Prevents car leaving road but is not high enough to endanger passengers.

responsible for the satisfactory maintenance of that section. The patrolman is furnished with an assistant, and is supplied with the neceessary tools and equipment for doing the maintenance work. Whenever major repairs are to be made on a section, a floating gang is dispatched to do the work; while the patrolman and his helper continue their regular duties.

Essentials.—The two most important operations in gravel road maintenance are the dragging of the surface and the adding of surfacing materials. Dragging is the predominating factor and should receive utmost consideration.

Gravel roads must be dragged at regular intervals regardless of weather conditions. Regular dragging retards the development of corrugations and brings back the loose materials that have been forced by traffic to the sides of the roadway. The loose material, when evenly distributed over the road surface, provides a mulch which takes the traffic wear and prevents the raveling of the surface.

Machinery for Dragging.—Road graders or blade machines have not proved satisfactory for dragging gravel roads. A single blade run over the road does not accomplish the results desired. Exceptionally good results can be obtained, however, by using road drags or on the principle of the more refined Wisconsin or Minnesota drags.

The one great objection to the use of drags for maintenance work in the past has been the inconvenience of moving them when not in use. This objection has been overcome, and manufacturers of road machinery are now making devices mounted on wheels with all the desirable features of the old fashioned drags incorporated in their designs. The improved drags are sold under the name of "Road Maintainers" and are equipped with a set of small scarifier teeth placed in front of the blades to loosen the compacted surface. Provisions are also made for the regulation of the cutting depth of the blades.

Frequency of Dragging.—There are a number of factors which control the frequency of dragging. In an arid or semi-arid region experience has shown that roads carrying less than 100 motor vehicles a day can be satisfactorily maintained by dragging once every two weeks; roads carrying 100 to 250 vehicles a day require weekly dragging; and those carrying more than 250 vehicles a day should be dragged two or three times each week..

Speed of Dragging.—If drags are moved over a road at a greater speed than three miles per hour they chatter and bounce about and consequently jump over the bumps instead of cutting them down. It is, therefore, imperative that the dragging be done at a very low rate of speed.

Power.—The motive power for pulling drags can be furnished either by four-wheel drive trucks or by tractors. The expense of operating tractors in place of trucks warrants the use of trucks whenever possible. For regular maintenance the weight of the drags should be limited to a weight that can be drawn with the draw-bar horse power furnished by trucks.

Whenever it is necessary to use heavy drags or road planers on well compacted surfaces, tractors are needed to furnish the motive power. Considerable yearly savings in the expense of equipment replacements and repairs can be made by using tractors only for such work as cannot be accomplished by trucks.

Additional Surfacing.—As the success of a gravel road depends upon its top dressing, it is necessary to place additional material on the surface whenever the material becomes lost in the roadbed or worn away. Soil conditions and traffic regulate the frequency and the quantity of fresh material which should be added.

On well drained roadbeds having average soil conditions and carrying 600 vehicles a day, 300 cubic yards of fresh gravel should be placed on each mile every three years to properly maintain an 18-foot surface.

Oiling.—Very sandy roads are best maintained by giving them a light application of fuel oil, after which regular dragging must be carried on. Precautions must be taken to use oil that will not have a tendency to mat or cake. Not more than one-quarter of a gallon of oil should be used to the square yard, and the road surface must be kept in a loose condition by dragging.

Cost Records.—Accurate cost records are valuable in controlling maintenance work; therefore, sufficient data should be secured in the field so that correct records may be kept. The information should be segregated so as to obtain the unit cost per year for the following items:

Cleaning culverts and ditches; raking rocks; cutting weeds and brush; repairing washouts; dragging; additional surfacing; guard rail; sprinkling; painting; building and repairing ditches and culverts; administration.

Maintaining Wyoming Roads

Most of Wyoming's highways which have received any surface treatment other than grading are surfaced with gravel, and the maintenance of these gravel roads is the big job of the highway department. The cost of this maintenance has been analyzed by G. W. Marks, district highway engineer, and the result of his analysis is given below.

Some of the main traveled highways should be gone over three times a week during seasons of heavy travel, wet or windy weather. It is believed that the average road should be dragged at least every five days. In most parts of the State the nature of the country is such that it is impracticable to use horses for pulling drags or graders. The cost of getting feed and water on the job makes this prohibitive and consequently most of this work is done by trucks or tractors.

Dragging—The cost of operating a truck and drag or grader is from $18 to $26 per day; this including

salary of operator, gas, oil, depreciation and upkeep of equipment. To do good work, a truck should not drag faster than four miles an hour and must make at least two round trips over the road to properly smooth the surface and remove excess loose material back to the side of the road. Allowing for time lost in going to and from the work and other delays, a patrolman does a good day's work if he averages six miles of road a day. This makes a minimum cost of $3.00 to place one mile in condition. Dragging the average road once in five days would make an average daily cost of 60c for the season, while there are about 240 days of heavy maintenance in Wyoming and consequently there should be vailable about $142 per mile per year for this class of work.

Gravel—It is estimated that the loss from wear under the present high-speed and heavy traffic is from 5 per cent to 10 per cent. The standard yardage per mile is a little over 1,700 and and the minimum cost of gravel in place is about $2.00 per yard while considerable of it will cost $6 or $7 due to the long haul. This would make a minimum cost of $170 per year per mile for gravel replacement. In most parts of Wyoming the winds are quite high and remove the dust which serves as binder as fast as it is formed and the replacing and mixing of this binder with the gravel costs about $10 per mile per year. This brings the gravel maintenance up $180 per mile per year.

Ditch Maintenance—The cost of maintaining surface ditches is not very great, although rain may make expensive repairs necessary. Side ditches, however, require frequent blading to remove weeds and dirt. The average cost of cleaning and maintaining ditches is about $12 per mile of highway per year.

Culverts—During the winter the snow drifts into culverts, and this and melting snow which runs into the culverts form ice when it again freezes. If this were allowed to main until the spring runoff started, extensive damage would result. During summer, weeds and dirt collect and must be removed before winter. In various ways end walls are sometimes damaged and must be repaired. All this probably costs an average of about $1.50 for each culvert, and as the culverts average 10 to the mile that would make the cost $15 per mile for culvert maintenance.

Structures—Many old bridges still remain on the state highways, although they are being replaced as fast as finances will permit. The cost of replacing worn out decks, broken stringers and rotten piling, as well as painting, is considerable. Adding to this the cost of painting and repairing guard rails, this work costs a little over $12 per mile on the state highways in Carbon county, the territory of which Mr. Marks is in charge.

Reshouldering Embankments—Wind, rain and stock are constantly wearing away the sides of embankments and this wear must be replaced. For this work tractors and heavy graders are used except on high grades, where teams and fresnos are used. With tractors this work costs about $40 per mile. Where teams are used it costs from $100 to $200. A fair average would be about $75 per mile; and as each stretch of shoulder has to be gone over about once in three years, this would make an annual cost of $25 per mile.

Direction and warning signs are used for targets by so-called sportsmen, and stock find them handy for rubbing the loose hair off their heads and necks. Repairing such damage involves an annual cost of about $3 per mile.

Summing up these items we have the following cost:

Surface maintenance	$144.00	34.8%
Ditch maintenance	12.00	2.9%
Culvert maintenance	15.00	3.6%
Structure maintenance	12.00	2.9%
Reshouldering	25.00	6.0%
Replacing surfacing	180.00	43.4%
Sign maintenance	3.00	.7%
Total	$391.00	
Supervision @ 6%	23.46	5.7%
Total one mile maintenance for one year	$414.46	100.0%

The above does not take into account snow removal in the winter or washouts or accidents that might be the cause of additional expense, but may be taken as an average on those routes having a traffic which does not exceed 500 vehicles per day.

Low Cost Roads in New Mexico

With an average population of less than three to the per square mile, the state of New Mexico could not well be expected to build high-cost roads, which would be an excessive burden on the tax payers. It therefore adopted the policy of building sand-clay, gravel and other low-cost surfaces on well graded and well drained road beds.

Up to the beginning of 1925, about 138 miles of road had been completed, and during the year 1925 about 1,478 miles were surfaced. During 1926 a somewhat larger mileage of grading, gravel and sand-clay surfacing, with a small amount of paving, was completed. The total mileage of the state road system is 9,159. The average cost of all types of improvements receiving Federal aid during the past year was about $10,800 a mile, of which only a small part was paid directly by the counties.

The state highway system is maintained entirely by the patrol system, each patrol having a section of about twenty miles on the average. Dragging is carried on almost continuously on many patrol sections to keep down corrugation. Trucks are used for more extensive repairs such as patching holes in gravel, surfacing worn sections, and cleaning drainage channels. The one-man maintainer or small patrol grader, with the engine controlled by the operator, is widely used.

Mississippi Highway Work

We are informed by the State Highway Department of Mississippi that the method employed by that state in constructing graded roads is no different from that employed if the road is to be paved also. In other words, they apply the same kind of construction to graded roads and to roads that are to be gravel surfaced as they do to the highest type

of roads which they construct; the idea being that a permanent pavement is only postponed and that all grading work must be final and the investment in it made permanent.

Road Construction and Maintenance in Arkansas

By R. C. Limerick*

Many miles of earth roads have been constructed by state forces in this state by means of tractors and blade graders. I find this method quite satisfactory and economical where the height of fill and amount of dirt to be drifted is not excessive. In the instance of a shale or loose rock formation, the costs

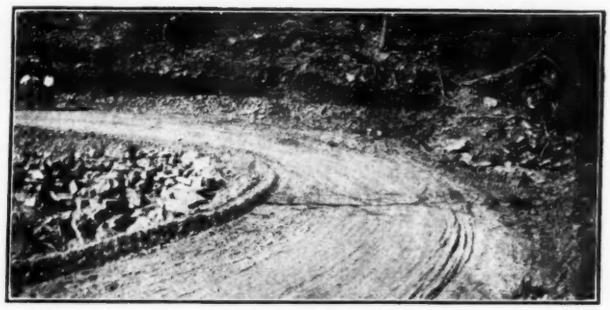
OPENING A ROAD IN SALINE COUNTY.

of construction are lowered considerably in comparison with team work. In addition, cleaner and more attractive looking work is obtained by means of mechanical equipment than by means of teams, the side ditches being cut to more uniform lines and grade than with slips and wheelers, and the roadbed assuming a more uniform cross-section. This proves true whether in hillside work in the mountains or work in the level sections of the Mississippi Delta. In general, I find that a ten-ton tractor pulling a 12-foot blade grader proves the most effective. Where the topography is quite rolling it is necessary to follow up the mechanical equipment with some dressing by teams, but on the whole quite pleasing gradients are obtained solely with the use of tractor and blade.

Where gravel, chert or burned shale surfacing is placed, either by state forces or by contract, the trench method is generally used, the surfacing being placed to a uniform depth over the entire designated width in two courses, the bottom course being slightly greater in depth than the top course. The material

*State Highway Engineer of Arkansas.

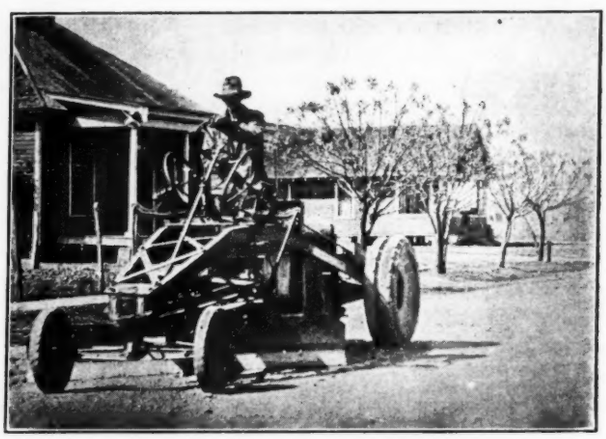
TRACTOR AND GRADER OUTFIT, NEW IN 1926.



HAIR-PIN TURN ON BOSTON MOUNTAIN.

excavated from the trench is used to form the shoulders. A minimum crown is used, about ⅜ in. to the foot, in order that traffic will not segregate into lanes.

Maintenance of either earth roads or gravel, burned shale or chert roads, is acomplished by means of dragging or blading. It is believed the best results are obtained through the use of a 6 or 8-foot blade grader when the same is properly handled. All maintenance work is done by state forces, and mechanical power is almost universally used, as a Fordson or truck can be diverted to numerous other duties as occasion demands. In general, it is believed



MAINTENANCE WITH ONE-MAN GRADER.

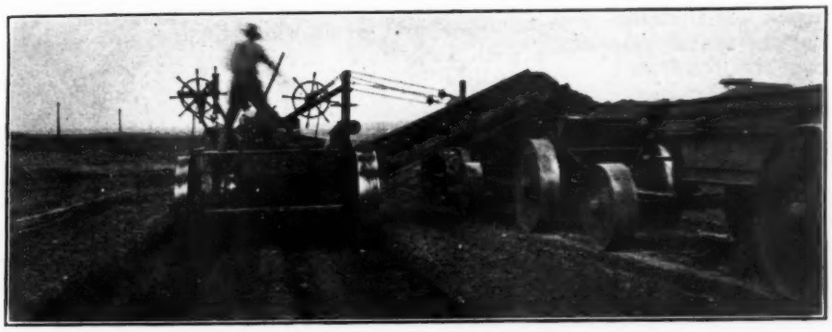
that a surfacing material containing no aggregate in excess of a size passing a 1¼ in. screen will prove the most satisfactory for use from the standpoint of maintenance. Such material is easily worked and does not tend to form corrugations or pot holes as does material containing larger sizes of aggregate.

REPAIRING GRAVEL SURFACE WITH BURNED SHALE

Construction and Maintenance of Gravel Roads in Iowa

By L. L. Clement*

Of the Primary System of highways in Iowa, 2,800 miles of road were classified as gravel on December 1, 1926. This mileage of gravel roads which has practically all been built within the past ten years, is located in the territory occupied by the Wisconsin glacial drift extending as an irregular triangle over the northern half of the state with the apex of the triangle near the center of the state at Des Moines.



EARTH GRADING WITH ELEVATING GRADER

CONSTRUCTION

Preliminary to placing a gravel surface on the highway, surveys are made, plans prepared, and the earth road graded and drained, all under the jurisdiction of the State Highway Commission. The grading is done by contract, generally using elevating graders and dump wagons. Drag lines are utilized to some extent in building high fills across low land where the earth is available for borrow alongside the road.

After the grading has been completed, traffic is turned over the earth road for a period of several months (preferably over winter) to help compact the fresh grading. The shoulders are then reshaped and the road is bladed to a uniform flat or nearly flat cross-section (Not over three inches of crown in a 28 foot roadbed).

Gravel is then hauled by trucks and dumped in piles along one shoulder of the road. To assure a uniform spreading and mixture, the piles of gravel are dragged across the road, leaving about one inch of loose gravel on the surface with the balance of the gravel in a windrow along the shoulder.

The Iowa specifications require that material used for road gravel shall be obtained from a source of supply approved by the State Highway Commission and shall all pass through a screen having one inch square openings or one and one-fourth (1¼) inch round openings.

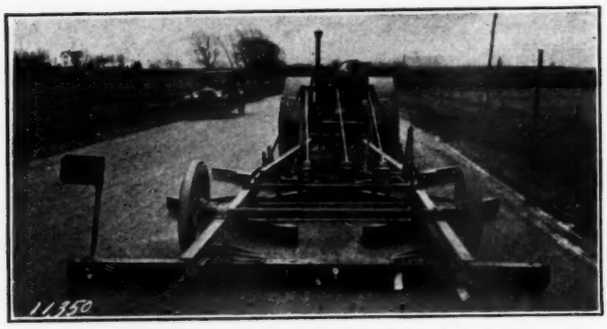
Owing to the excessive amount of gravel larger than one inch in diameter found in the majority of local pits in Iowa, crushing the gravel at the pit is usually required. In this operation, the pit run gravel is elevated and carried over a shaker or cylindrical screen, the oversize goes to the crusher and the crushed gravel is again elevated and carried over the screen. The material passing through the screen drops

GRAVEL SPREAD TOO THICK ON ROAD, CAUSING AN EXTREMELY DANGEROUS CONDITION

*Maintenance Field Engineer, Iowa State Highway Commission.

SHAPING SHOULDERS AND BACK SLOPE PREPARATORY TO PLACING GRAVEL

EXCESS GRAVEL IN WINDROW ON ONE SHOULDER OF ROAD



MULTIPLE-BLADE MAINTAINER WITH MOTOR PATROL

into a bin with hopper bottom and is loaded directly into the hauling trucks.

Experience in Iowa has shown that best results are obtained by placing about 1,000 cubic yards of gravel per mile of road at the first application. This gravel is placed on the road and spread as a construction project and the highway is then turned over to the Maintenance Department of the State Highway Commission.

MAINTENANCE

Continual surface maintenance is necessary on the gravel road to prevent the formation of ruts and corrugations. Equipment used includes tractors with blade graders or multiple blade maintainers, one man power maintainers, trucks with blades and horse drawn blades. The equipment to be used on any particular road depends primarily upon the amount of traffic and character of gravel on the road.

Patrol districts in direct charge of a patrolman vary in length from six to eight miles for horse drawn outfits and 15 to 18 miles for power equipment. The patrolman's first duty is to maintain a good riding surface with a crown of from four to six inches, after which he repairs shoulders, cuts weeds, cleans ditches and does whatever is needed to keep his patrol section in good condition.

Resurfacing or maintenance gravel is hauled and spread under the same specifications as the original gravel construction project, the amount of gravel placed depending upon the condition of the old gravel surface.

During the winter months it is our policy to remove the snow from the entire primary road system. This policy has been adopted for gravel roads not only to keep the roads open for automobile traffic, but also to prevent an accumulation of snow which, when melting, soaks into the road and causes a soft subgrade and consequent loss of gravel. Before adopting the snow removal program, on numerous occasions we found that replacing the gravel lost due to snow melting on the road actually cost more money than the removal of the snow.

A WELL-MAINTAINED GRAVEL ROAD

Snow fence is extensively used to prevent drifts and the snow on the road is removed by the use of regular surface maintenance equipment, push plows attached to tractors and trucks, and in localities subject to extremely heavy snow, rotary plows are found to be indispensible. These rotary plows are used not only to open the roads, but to widen the traveled way after a one-way track is opened.

SUMMARY

Summarizing our methods of construction and maintenance of gravel roads, the experience in Iowa has proven that it is good practice to—

(1) Grade and drain the highway in accordance with a carefully prepared design.
(2) Allow newly graded road to settle and then reshape before applying gravel.
(3) Use care in selecting gravel materials.
(4) Crush and screen gravel.
(5) Spread gravel uniformly over road surface in a thin layer.
(6) Maintain surface constantly.
(7) Remove snow from road surface.

Sand-Clay Roads in South Carolina

By Charles H. Moorefield*

In South Carolina, the most common type of low-cost improved road surface is that made of sand-clay mixtures. This type of road, under proper maintenance, when made of properly blended materials of good quality, provides a good surface for all but the very extremes of climate found in the State.

The surface course may be composed of either natural or artificial mixtures of sand and clay. The ideal combination seems to be from 12 to 15 per cent of clay mixed with a rather coarse sand, although the finer sands, under 16 mesh size, give good results. In construction, the surfacing material is spread over the sugbrade so as to give a compacted thickness of 10 inches at the center, feathering to 4 inches at a distance of 10 feet from the center line.

It is essential for good results that the materials be well mixed, for which purpose a cut-away disc harrow is found effective. After mixing the material should be brought to proper crown by the use of a heavy road-machine, and reshaped after each rain or whenever the surface becomes rough or rutted.

In long dry spells, when road machining is not very effective, the surface at times becomes "corrugated." In long wet spells the surface becomes slippery and muddy in places. But in general, the surface provided compares very well in smoothness to a paved road; and with an expenditure of around $375 per mile per year for an average traffic of about 500 cars per day, can be maintained in satisfactory condition.

The material for sand-clay roads is obtained by

*State Highway Engineer of South Carolina.

contractors from roadways, fields or pits; the last, with necessary rights of way, being furnished free to the contractor by the state. When the subgrade of the road is either a sand or a clay of satisfactory quality, the other ingredient is added and the two mixed together thoroughly. Clay subgrade is first plowed to a depth of 4 to 8 inches, harrowed with a cut-away disk harrow until pulverized, and 4 to 8 inches of sand spread over it. A sand subgrade is leveled off to the subgrade section and 3 to 6 inches of clay spread evenly over it. When the subgrade material is not suitable for a surface mixture, 3 to 6 inches of clay is spread evenly, followed by 4 to 8 inches of sand. The material is then twice plowed and harrowed to mix it and is then shaped by a road machine. Plowing is begun at the outer edge, the material being turned away from the center, and then harrowed until pulverized; and the same is repeated, beginning the plowing at the center and turning the material toward the center. No hauling over the mixed surface material is permitted until it has been shaped.

Tennessee's First-Stage Highways

In order to utilize its highway resources to the best advantage, and provide for present needs as far as possible but with a view to the future, Tennessee has adopted what is known as the two-stage construction of its roads.

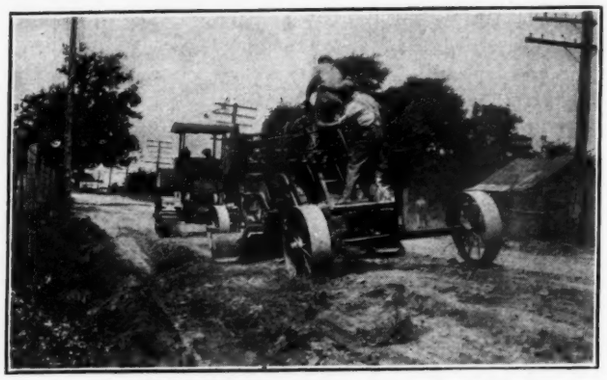
The first stage consists of the locating of a road and the grading and drainage. This provides a practically permanent alignment and width of right-of-way, with proper grades. One of the lower types of surfacing is then placed on the new grade, consisting of either gravel, stone, slag or macadam. This temporary surfacing insures safe travel, allows proper settling of fills, and affords a means for the increase of traffic; which increase then gives an indication of what higher type of road paving may be necessary. The second stage consists of the surfacing of the graded road with the type of surface made necessary by the traffic demands and suitable under all conditions which have been studied.

EARTH ROAD MAINTENANCE IN WEST TENNESSEE

Previous to 1917 practically all the state highways were in bad condition. In that year the legislature inaugurated a more systematic method of licensing motor vehicles, one-half of the proceeds from vehicle registration being distributed to the counties to be used under the supervision of the State Highway Department. Most of this was expended toward maintenance, but necessarily under the immediate direction of the county officials because the state department was not organized to supervise and to coordinate this phase of the work.

Beginning with 1924, however, the Department of Highways and Public Works took over active control of the automobile funds and by July, 1925, the department was administering the funds on the requisition of state engineers rather than through county officials, and the responsibility for the maintenance of the entire state highway system rests upon the department. The maintenance equipment which has been purchased by the department from its general fund has been assigned to county maintenance without deducting its cost or its rental from the counties' share of the automobile fund.

WELL-MAINTAINED GRAVEL ROAD IN HARDIN COUNTY



GRAVEL MAINTENANCE IN TENNESSEE

Since May, 1925, when the Department of Highways took over the entire state system of approximately 5,000 miles for maintenance, old roads full of chug holes, rough and muddy, have been transformed into smooth riding roads serviceable the entire year. The main object has been to provide for

HEAVY CUT IN CHEATHAM COUNTY

the ever increasing traffic. Then, as soon as the old roads become travelable, reconstructive maintenance began, providing better alignment and safer conditions.

Since an abundance of stone and gravel is found

OIL TREATED ROAD IN WILSON COUNTY

in practically all parts of Tennessee, with the exception of the western section, these materials have been used extensively and have been found to make a very satisfactory road for modern traffic, as well as a serviceable and economical road for temporary purposes under heavy traffic conditions.

A large percentage of the work performed as maintenance by the department should properly be termed "reconstruction." Practically all the roads in the state highway system not constructed to the department standards have been graded or reshaped by the use of heavy grading machinery, short sections have been relocated to improve alignment, and the roads have been continually maintained by road drags, light blade graders, and other equipment. In the sections of the state where local material is available, gravel, chert, and macadam have been used for surfacing. The department has found that the secret of maintaining satisfactory riding qualities in roads of these types lies principally in keeping smooth, by constant dragging or blading, a floating layer of the surfacing material.

The state highway system has been divided into sections and patrols established over each section, giving each patrolman a definite responsibility and the requisite machinery and requiring him to keep his section in good riding condition. In the First, Second, and Third Field Divisions, stone, gravel, or chert is locally available and these materials have been used on practically all highways in these Divisions. In the Fourth Field Division, which lies west of the Tennessee river, a lack of local materials has made the problem of maintenance more difficult, though good results have been accomplished by the reshaping and dragging of earth roads. As earth roads are not satisfactory for year-round automobile traffic, large quantities of gravel or chert have been shipped into the particular localities where most needed and spread over the earth roads in a layer of sufficient thickness to provide a surface which may be easily travelled the year round.

During the summer of 1925 a number of experiments were undertaken, and a careful study of similar work done in other states was made, to discover the best method of oiling gravel and macadam roads. This study resulted in the adoption of construction details which have permitted the reclaiming of several hundred miles of gravel and macadam roads with a bituminous surface which is dustless and which provides excellent riding qualities. This work, which might properly be termed major road improvements, is carried in the department's records as maintenance cost.

The funds for maintenance are derived from fifty per cent of the Automobile License Tax, which it is necessary that the department expend equally in each county, supplemented to the necessary extent from the general funds of the department. The maintenance program is operated on the budget plan. In November of each year the four field division engineers submit recommendations to the commissioner, upon which the approved maintenance program and budget for maintenance during the ensuing calendar year is based. These recommendations include the following information for each section of the entire State Highway System:

A—Type of existing road.
B—Condition of existing road.
C—Recommended improvements.
D—Estimated cost of improvements.
E—Machinery necessary for recommended improvements.

These recommendations are carefully studied and considered by the headquarters office to the end that the standards for all parts of the highway system may be maintained uniformly throughout the state and be in keeping with the importance of the road from the standpoint of traffic requirements. With the aid of the field division engineers' recommendations and other sources of information, the commissioner adopts a coordinated program of maintenance and approves the budget which it is estimated that the maintenance outline in the program will cost. After the adoption of this program, each maintenance section is established and the funds necessary to permit the work planned for the section are set aside.

The budget for the year ending June 3th, 1926, was based on an estimated income a little over $13,000,000, including $5,000,000 borrowed under Acts of 1925. The other sources were: Auto registration, $3,362,727; three-cent gasoline tax, $3,915,107; Federal aid, $2,377,547; County aid, $2,849,466. There were also miscellaneous receipts totaling $190,875. For 1927 an income of approximately $13,500,000 is expected.

Work Let to Contract 1918 to December 18, 1926

Type	Miles	Cost
Cement concrete	316.652	$9,740,653.47
Bituminous concrete	82.780	2,541,178.53
Sheet Asphalt	33.770	248,165.75
Rock Asphalt	92.088	2,778,697.02
Bit. Macadam	466.088	11,148,689.31
Waterbound Macadam	140.908	1,830,079.59
Surface Treatment & Miscl.	233.174	783,422.75
Gravel or Chert	419.108	3,286,393.30
Base	61.747	905,350.69
Grade & Drain	972.994	9,570,604.00
Bridges	.....	6,749,874.79
Total	2,819.309†	$49,583,145.20

†This mileage includes 334.620 miles of projects which overlap previous projects.

Projects Let to Contract in 1926, as of December 18, 1926

Type	Miles	Cost
Grading & Drainage	341.277	$3,831,641.27
Base Course w/o Surface	6.846	116,404.43
Cement Concrete	104.901	2,856,381.62
Bit. Macadam	12.121	180,860.84
Asphaltic Concrete	5.228	174,960.13
Rock Asphalt	5.594	219,272.53
Chert or Gravel	15.120	11,220.52
Bridges	.....	1,636,433.93
Total	491.087*	$9,127,175.28

*This mileage includes 103.855 miles of projects which overlap previous projects.

Garbage Collection and Incineration in Sewickley

Under this title we published in 1915 *an article written for us by Edward E. Duff, Jr., then borough engineer of Sewickley, describing the method of can collection and of incinerating the garbage practiced by that borough of* 5,000 *population. The system and its operation were very creditable for a community of that size at that time. In the following article (which appeared in "City Manager Magazine") John C. Hiteshew, borough manager of Sewickley, describes the new plant and collection equipment which succeeded the old about two years ago.*

The Borough of Sewickley, Pennsylvania, is a residential suburb of about 5,000 population, situated on the northern bank of the Ohio river, 12 miles west of Pittsburgh. It has an area of about one square mile, with a taxable property valuation of $8,500,000.

Prior to 1907, the garbage was hauled to the bank of a small run within the borough limits, where it was carefully washed and subsequently buried. This system, as can be readily seen, was far from satisfactory and the borough council took steps to relieve the board of health of their duties in this connection.

A twelve-ton incinerator was purchased and erected in a suitable two-story brick building on property purchased by the council at one corner of the borough on the Ohio river bank. Subsequent to this action, it was decided to purchase sufficient cans to accommodate all the residences and to arrange for a system of collecting and incinerating the garbage.

As stated before, the first plant was built in 1907, and beginning about 1920 the incinerator began to show signs of wear, requiring each year greater repairs and replacements and plans were made for the construction of a new plant to be built as soon as funds were available. Had the old plant been able to stand for a greater period of years it would have had to come down in the near future, as it was located on the proposed new location of tracks of the Pennsylvania Railroad Company through Sewickley.

THE NEW PLANT AT SEWICKLEY

Work was started on July, 1924, on the new plant, the site for which was located on the southern bank of the Ohio river about a third of a mile from the end of the Sewickley bridge, which crosses the river on a line from the center of the town.

The site was unusual in that the property was about 700 feet in length and 55 feet wide at its widest point, with a heavy traffic county road on the upper side, and the four track system of the P. & L. E. railroad immediately below, with numerous indications of slides on the site itself as well as on the hillside above. A difference in elevation

of about twenty-five feet between the roadway and the railroad tracks was very satisfactory from the standpoint of a two-story building with the charging floor level with the roadway and the furnaces on the lower floor with plenty of light and air.

Construction difficulties were numerous as can readily be seen, the roadside wall of necessity being a retaining wall with drains along and through the building for underdrainage and four buttresses were necessary to support the wall on the lower side.

It was decided to construct the furnaces in two units instead of one as in the old plant, as one unit was all that was needed at the present time, excepting in the peak season, the extra unit to provide for future growth and for use in case of repairs to the working unit. Two units of 15 tons in 24 hours each of the Morse-Boulger Destructor Co., were therefore built, the contract being let to this company for the destructors, complete building and stack. The building is 27 x 37 feet, of brick construction, and fully equipped with a can washing rack, a 300-gallon hot water tank, coal bin with 12 tons capacity, toilet immediately outside with septic tank and grease trap. The coal bin is small for the reason that we haul the coal direct from the mine with our own truck. The stack is 100 feet high and of radial brick construction.

Owing to the cramped space, considerable difficulty was experienced in planning an entrance for the garbage truck into the building, a hillside location necessitating two ramps, one for entrance and one for exit on east and west sides of the building; using a front or roadside entrance would have interfered with heavy traffic on the county road in turning and backing into the plant. We feel that this problem was satisfactorily solved by a 20 x 22-foot reinforced concrete platform on the east end of the building, allowing the truck plenty of room to turn and back into the building to the charging hole. The lower part of the platform was enclosed and used as a storage room for cans and supplies, also for housing the pump (city water was not available), the well for which was drilled through a manhole in the platform after construction. For lighting the building and operating the automatic pump which with pressure tank supplies the water for the washing of cans it was necessary to build a line from the Sewickley bridge.

CHANGE IN COLLECTION METHODS

At the old plant horses and special wagons were used for collection, one team and two wagons being needed, the loaded wagon being left to have cans emptied into the furnace and cans to be washed, and an extra wagon to be filled with the clean cans ready for the next collection. With the new plant, however, a two ton truck is used and with the two collectors and two plant men, cans are emptied into furnace, washed and placed again on the truck in 15 minutes, ready for the next collection.

INTERIOR OF SEWICKLEY'S INCINERATOR BUILDING

To supply the Borough 2,000 cans are now in use. The cans are made of galvanized iron, weigh 17¼ pounds when empty, and have a capacity of about eleven gallons. They are made on the following specifications: 12¾ inches in diameter by 19½ inches high, 20 gauge iron in body and bottom, 26 gauge tight fitting lid 1½ inches deep, wrought iron hoops ⅛ inch by 1½ inches shrunk around top and bottom, heavy drop handles 4½ inches from top. All cans and lids must be thoroughly galvanized and be guaranteed against leakage. About 500 of these cans are purchased each year at a cost of $2.10 each.

The cans are subjected to hard usage and our records show their life to be from three to four years.

The cans are placed by the collectors in any location convenient for the householder, no cans being placed on sidewalk, street or alley for collection. The cans must of necessity be comparatively small as in some instances the men have to carry two cans a distance of several hundred feet and very seldom less than fifty or seventy-five feet, while with the privately owned cans and on open wagon or truck the cans placed on the curb line require two men to lift them into the wagon or truck. A can twice the size could readily be handled.

Heretofore cans and bottles and a certain amount of rubbish had been placed in the garbage cans, but beginning with the operation of the new plant an ordinance was passed requiring all citizens to drain and wrap their garbage and place cans and bottles in separate receptacles which would be collected once a month by the street department forces. Rubbish is collected separately also, in May, August and October.

A special platform was built on the truck chassis, consisting of a flat bed or floor set about four feet above the street level and having uprights around the sides to which chains were fastened to prevent the cans from falling off.

Seventy-two cans are placed in six rows and as the empty cans are taken from the truck to be replaced with full cans, the collector shifts the remaining empty cans to the outside.

With the old plant, collections were made once a week, with the exception of the business section which was covered a week, with extra collections during the summer months. At the new plant an extra load was made per day immediately and in July and August, which is of course the peak season, six loads are made per day, an increase of 50 per cent in service during the heavy season.

From one to five cans are left at each residence, depending on the actual need, to be determined by the collectors, and as many as twelve at hotels and hospitals. We have found that two cans give ample accommodation for the average family, and where it is necessary to supply more than two cans, additional cans must be purchased by the householder, and these must be of same design and are exchanged the same as those owned by the Borough. In collection, the lids are not removed from the cans from the time they leave the residence until they reach the furnace, and there is consequently no nuisance created in emptying from one can to another or from the can to the truck.

The collection force consists of two men, the driver doing his share of collecting for a small additional amount. Two men are needed at the plant in washing cans, charging furnace, firing, stoking, and hauling out ashes.

The average net weight is one ton per load or five tons per day, excepting July and August when there are six loads per day. This is at the rate of 111,600 cans per year, or 1,560 tons of garbage per year.

Coal is used in burning the garbage. The specifications required 90 pounds of coal per ton of garbage consisting of 65 per cent garbage and 35 per cent rubbish, but owing to the character of town, with comparatively few business houses due to the closeness of Pittsburgh, we have a small amount of combustible rubbish of any real fuel value, and are using about 150 pounds of coal per ton of garbage.

The cost of the new plant complete was $41,500. We are saving $1,000 a year over the old plant, although the principal item of expense, labor, cannot be reduced as four men are absolutely necessary.

The cost of garbage service per capita for 1925 was $1.75. The cost of collection for 1925 was $3.28 per ton and incineration $2.90 per ton. There is no extra charge or tax assessed against the taxpayers for the garbage service, the total amount coming out of the ordinary revenue received by the Borough.

The incineration of garbage these days is considered the most modern and efficient method of handling this difficult problem, but the collection "nut" has a great many times been a hard one to crack. We feel that in our so-called "can system" we have the most modern, efficient, sanitary method possible and while the cost may be prohibitive in many places, in the long run it will be well worth it. With the most expensive and modern incinerator that money will buy and a crude, insanitary and inefficient collection system, the garbage service of a town will be judged, I firmly believe, by the system of collection it uses. In Sewickley the residents are relieved of all responsibility regarding the purchase of cans and payments for collection. There are no insanitary garbage wagons clattering over the streets, and there is no trail of garbage drippings from the back yard to the front street.

While our system is small in proportion to the needs of many towns and cities, I feel sure that, with proper management, the principles applied in the Sewickley system would be applicable in places many times the size.

Roping Off Streets for Parades

Most of the parades in San Francisco take Market street as their route, from the ferry building to the city hall. To confine the crowd to the sidewalks during parades, the police department has adopted the plan of stretching a strong cable along the street near the curb, this being supported by wooden posts at regular intervals. The posts are set into holes in the roadway pavement about a foot out from the curb. An iron cover, similar to the cover on a waterworks valve box, is kept over each hole when the posts are not in use. At street intersections the cable is laid in the adjacent gutter until a few minutes before the approach of the parade, when it is drawn taut across the intersecting roadway by the policeman in charge of each intersection.

In placing the guard cable, one truck distributes the wooden posts along the route of the parade while two distribute the wire cable, one on the south side of the street and the other on the north side. This distributing requires about 30 minutes. The trucks follow immediately behind the parade and remove the guard, the posts being loaded onto one truck while the others wind up the cable. The cables have been removed

from the three-mile course in approximately twenty minutes, with a crew of five men for each cable truck. The cable is in forty-five sections and these are wound up onto reels, the supports of which are bolted to the bottom of the truck.

Refuse Disposal in Connecticut *

Practices of various cities as to separation of refuse and method of disposal—hog feeding, dumping, incineration and reduction

When refuse collection and the disposal is being considered by a community, practically no thought is given to the subject of collection, yet the great majority of householders are affected much more by the character and cost of collection than by those of disposal. Method of disposal and the location of the disposal plant have considerable effect upon the method and cost of collection.

About three years ago a limited survey was made of refuse disposal conditions in various Connecticut communities, and of 31 cities and towns it was found 23 required garbage separated from ashes and rubbish, 7 do not require separation, and in one where incineration of refuse is practiced garbage and rubbish are collected together and ashes and cans collected separately. Even where all refuse is disposed of by dumping, better results can be obtained by separation and proportioning of the material. No Connecticut communities require that garbage be wrapped in paper by the householders. When garbage is fed to hogs or treated in a reduction plant the paper is bothersome, but wrapping garbage materially adds to the cleanliness of the garbage cans and tends to reduce the fly nuisance.

Wide variations in collection cost are caused by differences in conditions and procedures. Some cities are hilly while others are level. Some cater to the convenience of the householder, as by removing refuse from the rear of houses, and others do not. Collection costs more where houses are widely scattered or on large estates, than where they are close together. Also the length of haul to the treatment plant has considerable effect on the cost.

Where all refuse is dumped, the garbage is generally spread in thin layers and covered with ashes or borrowed earth. In hot weather, when often a minimum amount of inert material for cover is available, putrefaction of garbage on dumps may become decidedly objectionable. One of the most frequent and strenuous complaints in regard to dumps in Connecticut has been from fires. An adequate water supply, preferably from city hydrants, should be available for putting out fires on dumps. Portable rubbish burners are desirable. Completed parts of dumps should be seeded to improve their appearance. Some solution should be kept on hand which destroys fly maggots. Dumps are often overrun with rats. The city of Hartford engages under contract a firm which specializes in the destruction of insects and rodents. Middletown recently employed this concern to eliminate a prolific growth of cockroaches in their public dump which began to invade the houses nearby. Dumping of refuse on the banks of streams should not be permitted.

Only one Connecticut city, New London, has a municipal hog farm, the fifteen other cities that use hog feeding letting out the disposal, and usually the collection, to private contractors. An objection to hog feeding which is becoming a decided factor in Connecticut in forcing consideration of other methods of disposal is the lack of available areas in the cities or towns to be served. Increasing objection is being manifested to transportation of garbage into other communities due to odors from improper transportation and insanitary hog farms.

Only one incinerator is in use at present in Connecticut and this was installed in 1925 for the city of Stamford. It is of the Decarie type and has a rated capacity of 70 tons of garbage and rubbish per day. It handles the refuse from about 30,000 people. An engineer and five assistants are employed on an eight-hour basis. The plant costs about $115,000 and complaint is made that it is now overloaded and should be increased by the purchase of an additional unit. It is operated without nuisance and has generally proved satisfactory. Only about 30 tons of coal had to be used for additional fuel during the year 1925 and the entire annual cost was this amount of fuel, plus labor, depreciation and interest on investment.

Bridgeport is the only Connecticut city disposing of garbage by reduction. Work is now under way to install an additional indirect drier unit and a chlorination unit for the treatment of gases. The odors given off are undoubtedly due to a number of various sources some of which can probably be eliminated by improvements in construction and treatment. There is no question, however, that odors from reduction plants are difficult to control, which has generally lead to their location away from built up areas.

Twelve of the communities dispose of garbage by feeding to hogs; twelve by dumping or filling; one by sanitary fill, one by reduction and one by incineration; while the remaining four employ both dumping and feeding to hogs.

Total cost of refuse disposal and collection were obtained by the survey in 1923 and these indicate per capita yearly cost as follows, based on rough estimate of population served; collection of garbage and disposal by hog feeding 15 to 98 cents; collection of garbage and disposal by dumping 40 cents to $1.56; collection of garbage and disposal by reduction 57 cents; collection of both garbage and rubbish and disposal by in-

*Abstract of address before the New England Health Institute on October 1st, 1926, by Warren J. Scott, Director of Bureau of Sanitary Engineering, State Dept. of Health.

cineration, $3.00. Wide range of cost is caused, as explained above, by widely varying conditions and varying degrees of service rendered.

In general it has been found that in Connecticut both incineration and hog farms have been successful; dumping has been generally unsatisfactory, and reduction has decided disadvantages.

Snow Handling Organization

Under the direction of the Chief Engineer of the Department of Public Works of Baltimore, Md., the construction bureaus of that city were last year organized and assigned certain work and districts as their share, in the handling of snow. The bureaus so organized were the Highway, Water Supply and Mechanical Electrical Service, for plowing and removing; and the Bureau of Sewers for removal only. The Bureau of Street Cleaning was alloted 9 plows, having the eastern half of the central district for plowing and removal. This bureau was to continue snow removal after the assisting bureaus had withdrawn their forces, as was its practice in the past.

The Bureau of Highways, with 30 plows, was alloted all outlying districts. It was also to remove snow from bridges, the municipal harbor belt railroad, and other specially designated places.

The Bureau of Mechanical Electrical Service, with 7 plows, was to plow the western half of the central district and to remove snow from certain important streets and intersections.

The Bureau of Water Supply, with an allottment of 3 plows, was assigned to the northeastern end of the central district. It was also to remove snow from several important main streets.

The Bureau of Sewers, in addition to keeping all sewer inlets open, was assigned the removal of snow from certain main streets.

Syracuse Water Works Notes

Construction of masonry-enclosed standpipe. Cleaning six miles of 36-inch conduit. Repairing two conduits which had been displaced by rock settlement.

ORNAMENTAL STANDPIPE

The city of Syracuse has constructed a standpipe in Thornden Park in connection with its high-service water supply and encased the same in masonry in order to give it as attractive an appearance as possible. The standpipe or tank is of steel 77 feet diameter and 60 feet high with a capacity of 2,000,000 gallons. The foundation was built of reinforced concrete and the steel work was erected by the Chicago Bridge & Iron Works Co. The bottom is of 3/8 inch steel plates welded together. The bottom angle is also welded to the bottom plate. The 13 courses of ring plates vary in thickness from 1 1/16 inch on the first ring to 3/8 inch on the top ring. Outside butt plates were used on the first nine rings. All riveting was done with a jaw riveter and the caulking with a pneumatic tool. An 18-inch overflow pipe is provided which empties into a pool in the park.

On completion, the pipe was painted with three coats of heavy Bitumastic paint on the outside; and one coat of primer, one coat of Hermastic enamel and one coat of heavy Bitumastic paint on the inside.

A foundation of reinforced concrete separate from the tank foundation was built around the tank to support the casing tower. This casing tower is 88 feet in diameter and 80 feet high to the top of the dome which roofs over the structure. The walls are of litholite stone and red brick, and the dome is of concrete reinforced with steel I-beams and rods. A stairway leads to the top of the casing tower where a walk and railing are laid around the edge.

CLEANING A 36-INCH WATER MAIN

In putting into service six miles of 36-inch cast iron conduit to carry its water supply to Syracuse in 1925, that city found the water arriving to be so muddy as to be unfit for use and it was therefore necessary to clean the main. A thorough inspection of the inside of the pipe was first considered necessary.

This conduit is not laid to a continuously rising or falling grade but follows the profile of the right of way, and water collected in the low places which had to be pumped through manholes provided for this purpose where there are no blow-offs. As it was impossible to walk or crawl for a long distance in a 36-inch pipe, a special two-man car was made, equipped with a hand power drive and hinged in the center so that it could be folded up and put into the conduit through a 20-inch manhole. It was found possible to attain a speed of about 3 or 4 miles an hour in this car on the level, but on upgrade and in water the rate was much slower. During the work the conduit was illuminated by a storage battery searchlight.

The whole six miles was unwatered and traversed and a record made of everything found in the conduit. A great deal of mud, gravel and stones was found, distributed mostly along the low points and on the upgrades. Mud was found from three to six inches deep in stretches 100 feet long in several places. The gravel was bunched where an open joint or large stone caused a drift. Some stones were found weighing from ten to fifteen pounds. Other objects found were a shovel, bottle, iron driftpin, an 8-foot grade stick and two pieces of lumber. Several bad joints were found where the pipe had not been entered the whole depth of the bell and some where the pipe had raised or settled, causing the joint to pull out at the top or bottom. Many joints were poorly yarned, leaving the yarn hanging through the joint on the inside. Several joints were found where the joint material had flowed through the joint and hardened in the bottom of the pipe, forming a slab an inch or inch and a half thick and two to four feet long. One of the worst conditions

found was the existence of air pockets at high points and sumps at the low points, owing to the irregular grade of the conduit. The sumps reached a maximum depth of 18 inches, but most varied from 2 to 8 inches deep.

It was decided, after the inspection, to endeavor to remove all foreign matter from the conduit by flushing at high velocity. In order to do this, the conduit was cut in two near the lower end and a 90 degree bend inserted, followed by a length of pipe to divert the water into an open field and thence to a creek. An additional manhole was constructed and used for flushing as well as for entrance to the conduit. By turning into the conduit water from two old conduits which paralleled this one, a velocity of about 6 feet per second was obtained, the discharge averaging a rate of 30,000,000 gallons per day.

Inspection after the flushing showed that the conduit was practically clean except for such materials as could not be flushed out, and these were removed on a trailer car behind the hand power car. The cost of inspection and cleaning was approximately $3,395; this including pumping out the conduit, removing and replacing manhole covers, inspecting and cleaning by hand, cutting in new manhole and special work for flushing, damages to farms and crops from the water, and miscellaneous items.

REPAIRING 30-INCH CONDUIT

The two 30-inch conduits which bring water to Syracuse from Skaneateles Lake at one point pass along a very steep hillside about 365 feet high. A branch of the New York Central Railroad is located on a bench about 50 feet above the valley and the conduits on a second bench or shelf about 110 feet above the railroad. At the highest point on each conduit are gate and air valves inside of brick buildings known as gate houses. In the vicinity of these gate houses the excavation of trenches for the conduits was in solid rock.

About ten years ago considerable settlement occurred under each gate house and a wall was built just below the upper house which apparently stopped the settlement for several years. About two years ago the west end of the lower house showed settlement cracks but they were not considered serious. Following an earthquake early in 1925 a deep fissure was found over conduit No. 2 (the higher one) about 40 feet west of the gate house, and the 80-inch valve on conduit No. 1 was tipped out of plumb and the nearby lead joint drawn slightly past.

The slope from the conduits to the railroad tracks was so steep that material could not be cast down the slope in uncovering the conduits to inspect and repair them, and the road along the right-of-way was too narrow to permit turning with dump wagons. Accordingly the department rented two dump carts and a small tractor and with these uncovered the two conduits and drew the material along the narrow roadway about a quarter of a mile to a place favorable for spoiling the excavated material.

As conduit No. 2 was about 12 feet higher than No. 1 it was necessary to remove the cover and side from the former first. The rock was found to be solid limestone covered with about two feet of clay and containing many large fissures and seams, and many large masses of rock had slipped and settled considerably. One cavity in the rock twelve feet under this conduit was large enough for several men to get into to remove debris and this was filled solid with concrete. Many fissures were at least 12 to 18 feet deep and some large masses of rock were tilted and in an unstable condition. All of these were broken up and removed to a depth of about 3 feet below the pipe and two concrete piers were built under each length of pipe. All seams were filled with concrete and the exposed faces of the rock now present a solid surface. The tops of the piers were left level with the bottom of the pipe on the uphill or bank side and were brought up as high as the center of the pipe on the downhill side. This will permit any single pier to slip and move downhill without carrying the pipe with it.

UPPER CONDUIT SUPPORTED BY CONCRETE PIERS; WORK UNDER WAY ON LOWER CONDUIT.

After the upper pipe line had thus been supported, the lower one was treated in much the same way. While working on the upper line several joint leaks occurred in the lower, indicating that settlement had pulled the lead joint part way out. The condition under and around this conduit was similar to that under No. 2. Levels taken on this pipe line show that it is now more than three feet lower than when laid 32 years ago. The brick gate house had settled until the west end was eight inches lower than the east end.

This work was naturally expensive. Although the rock was very hard it was not considered safe to blast it, both because of danger of breaking the conduits and also because rock would probably be thrown over the tracks of the New York Central Railroad. The necessity of avoiding all possibility of breaking or damaging the conduits was the more urgent because of the fact that the entire supply of the city passes through these two pipes, and the distributing reservoir holds only four days' supply.

The High Man Got the Job

It doesn't seem possible yet it actually happened right here in Louisville last week. If you don't believe us, why, just listen to this.

Kenneth Barker and Henry Bickel entered bids recently with the city for a number of alley contracts. When the bids were opened it was dis-

covered that both of their bids amounted to $10,800, which was also the low figure.

Instead of resorting to the moss-covered custom of tossing a buffalo nickel and leaving all to the gods of chance, Mr. Barker and Mr. Bickel decided to settle the matter by a game of skill. So we next find them over at the bowling alleys on 5th street. Mr. Bickel proceeded to ring up a score of 150 but Mr. Barker, bowling as he had never bowled before, came through with the remarkable score of 234.

And this is how it happened that the high man got the job.

(From *"The Scraper,"* the monthly publication of the Kentucky Association of Highway Contractors.)

Uses of Pitometer in St. Louis*

Studying flow conditions of distribution feeders, measuring the result of pipe cleaning, and testing large meters.

By Meyer Serkes†

The results of a pitometer survey made in St. Louis in 1912 showed conclusively the advisability of continuing such work, and the water department purchased several pitometers and has since maintained its own pitometer department which has been carrying on routine leak detection work on a small scale to very good advantage.

During the past year a 2nd class residential section was surveyed, in which the following leaks were detected: 371 faucet and toilet leaks, 3 service pipe, 3 fire hydrants and 10 street valves. These leaks constituted a wastage of 327,000 gal. per day or 119.6 million gallons per year. During the house to house inspections in this district, additional revenue was added in that 381 automobiles and 161 washing machines, which are taxed on a flat rate basis, were placed upon the books.

The section investigated, comprising a population of 20,000, showed a consumption of 96 gal. per capita before, and 88 gal. after the leaks were taken up.

These figures, which are far below the general average consumption of 145 gal. per day for the entire city, prove the section to be a good one and seem to indicate that the consumption in the industrial districts must be responsible for the increased per capita consmption.

SURVEYS OF DISTRIBUTION FEEDERS

In the early routine pitometer leak work it soon became apparent to us that a broader and more comprehensive use of the pitometer could be made in a study of the exact flow conditions existing during maximum and minimum periods of the day in all the main feeders of the distribution system.

Since this time the department has continued using the pitometer in making distribution feeder surveys yearly, whereby some mains were found to be doing no work whatsoever, and others as doing more than their share with velocities higher than desirable causing excessive friction losses in the line.

These data obtained yearly are used to very good advantage in new distribution design, and in the modification of the existing system, so as to equalize the work by the various overtaxed feeders, thereby enabling better pressures to be maintained at critical points in the system.

The St. Louis distribution system consists of two pressure systems, a high and a low, separated in the system merely by the closing of certain valves. The high pressure starts with 120 lbs. at Baden Station and the low pressure with 80 lbs. at Bissell's Point.

In one instance, a few years ago, it was observed from pitometer flow readings that none of the low pressure main feeders on and east of Grand Ave., which supply the Compton Hill reservoir, were taxed to capacity; that about 50 per cent of their total flow was supplied directly to the reservoir during the night period, between 6:00 p. m. and 6:00 a. m. The central feeder in this district, a 36 in. main on 20th St., was observed to deliver practically no water from Chouteau Ave. southward, during either the day or night.

When the problem of providing a new outlet for a high pressure pump from Bissell's Point to a section in South St. Louis, which was giving us trouble during periods of high consumption, came up for consideration, it was decided to take advantage of the condition found to exist in this 20th St. 36 in. main and turn it into a high pressure feeder.

By some minor changes and disconnections from this 20th St. main, it was directly connected to the high pressure pump and made to carry water at the rate of 15 million gallons per 24 hours, into this critical section of South St. Louis, thereby avoiding the laying of a new 36 in. main as was proposed previously at a saving of $140,000 and increasing pressures about 14 lbs. at this critical point.

In another case it was observed that a 30 in. low pressure feeder in Forest Park Blvd. from Grand Ave. to Sarah St. was carrying an almost insignificant amount of water. By a few additions and cross connections to this main it was taken out of low service and turned into a high pressure feeder so as to augment a 36 in. high pressure feeder across Grand Ave. which was congested during periods of large consumption between Bissell's Point Station and a point south of Olive St.

During the past spring when an important 36 in. cross town feeder had to be shut down in a certain section to make repairs, it was thought

* From paper before the Iowa Section, American Water Works Association.

† Assistant Engineer of Water Division, St. Louis.

that an existing cross connection to this feeder, just north of the point where the repairs were to be made, would divert most of the water eastward, and into another cross town feeder which was not taxed to capacity.

Upon checking up with the pitometer the estimated flow that this cross connection was to carry, it was discovered that the main carried no water whatsoever, and immediately upon checking the valves on this line we found a valve closed, which was supposed to be open.

Last year a pitometer flow survey was made upon all the high pressure feeders of 20 in. and over, in which valuable data were obtained, whereby recommendations were made for changes now in progress to the present system, which, when completed and inter-connected with the new Missouri river source, will give a direct supply to those sections in South and West St. Louis which are urgently in need of relief.

The use of the pitometer, therefore, is an important factor in the study of the correct functioning of a distribution system.

MEASURING PIPE CLEANING RESULTS

A number of years ago an extensive pipe cleaning program was undertaken to reduce the friction losses and to restore the carrying capacities of some of our oldest mains, which have been in service previous to the installation of our rapid sand filtration process.

In this work the pitometer was used extensively in determining the pipe coefficients, friction losses and carrying capacities of the various mains before and after cleaning.

The contractor guaranteed to restore the carrying capacities of mains cleaned to within 5 per cent of that of new pipe, using Weston's table of flow as a basis. Tests made upon some of the mains, before cleaning was started, showed carrying capacities from 40 per cent to 60 per cent of new pipe and tests run immediately after the cleaning showed gratifying results of 95 per cent of new pipe.

METER TESTING

In many cases where it is expensive and very difficult to take a large meter out of service for testing in the shop, the pitometer is resorted to in making a test in place with extreme accuracy.

A few years ago, in making such a test, a 6 in. meter was found to under-register about 15 per cent. This error was caused by an inexperienced meter man who made a change in dial gears in the field after making a small flow test. Since this meter supplied a very large consumer of water, the amount of unregistered water was estimated and a bill for several thousand dollars was presented and collected without much difficulty when the details of the incident were explained.

Again during the war period, the Government, which purchased water from us for its reservation through two 6 in. meters in tandem, disputed the correct registration of these meters, by a check at their Venturi meter in their pump station.

A test with the aid of the pitometer proved that our meters were within the limits of accuracy required and that the error was in the indicating device of the Venturi meter.

Such tests as these, where disputes occur and which are made in direct observation of a consumer, leave no doubt in his mind as to the merits of the case.

Loss of Reservoir Capacity Through Erosion

In a bulletin entitled "The Financial Limitation in the Protection of Reservoirs," by W. W. Ashe and issued by the Forest Service of the U. S. Department of Agriculture, the money value of prevention or reduction of the silting up of reservoirs is discussed, and the sums which can therefore be employed economically in such prevention by planting of trees on the run-off area or otherwise.

The bulletin shows that with storage there enters the problem of siltage through erosion of soil, an insidious agency which may cause loss of pondage and consequent reduction in the capacity of reservoirs.

The rapidity of erosion and of silting up of reservoirs is affected by different physical and meteorological conditions in the different regions of the United States. Over the greater portion of northern and northwestern United States and in Canada erosion is not the serious problem that it is in parts of the Southeast, and particularly in portions of the Southwest. The bulletin calls attention to the high silt burden of certain streams and the rapidity with which storage capacity or reservoirs is reduced, as in the case of the Colorado River (of Texas). The reservoir at Austin on this river lost more than half its capacity within ten years. Many other streams carry a silt burden fully as great as that of the Colorado. On the basins of certain of these streams, according to Mr. Ashe, the surface conditions are such that erosion can be materially reduced. On others the conditions are such that erosion can be only slightly lessened. On these it is a natural condition, the result of concentrated rainfall on surfaces naked of protective vegetation on account of irregular rainfall. There are other regions, the bulletin points out, where protection of the surface is highly efficacious in reducing erosion.

It is shown that it is possible to ascertain the rate of silting which is taking place and from this to determine the capital value of the storage capacity, the loss of which might be expected within a given period. It is also possible to determine the extent to which excessive erosion may be checked by artificial means. Mr. Ashe proposes a formula for determining how much money could be economically expended to maintain this capital value, which otherwise would be destroyed by siltage. He points out that in case woods are artifically established for the purpose of securing soil cover and reducing erosion, a definite return can be expected from the invest-

ment therein, but that power and water companies are justified in making additional expenditures which would be within the capitalized value of the storage capacity which will be preserved.

In the Southern Appalachians as well as elsewhere there are alluvial lands which have been injured during floods by gullying or by the deposit of sand and gravel. Where such conditions exist there is, in the opinion of Mr. Ashe, an opportunity for the establishment of settling basins. Settling basins of the kind he proposes would not only result in the elimination of much silt from the stream, but also would bring about the rehabilitation of the devastated lands, which after being built up by deposit of the sediment would again be available for farming. Since this sediment as a rule consists largely of the most fertile soil eroded from the surface of the watershed, areas thus built up would be very productive.

Improving Sewage Sludge Digestion

Suggestions for Applying in Practice in Sludge Digestion Some of the Results Obtained by Investigations Made at the New Jersey Agricultural Experiment Station.

By Willem Rudolfs*

Nothing during the past two or three years has aroused as much interest among sanitary engineers generally as the exhaustive investigations, being conducted at the New Jersey Agricultural Experiment Station, of the natural agencies involved in sludge digestion, their inter-relations and reactions, and how they may be controlled to stimulate the desired results and inhibit objectionable ones. Only recently have these investigations reached the point where those in charge felt justified in forming definite conclusions and making them public; although many of these have been held tentatively for some time, waiting for more complete confirmation; and many more are still in this condition, to be in their turn given to the public as confirmatory results are reached.

It has been our privilege from time to time to publish in PUBLIC WORKS *announcements of these findings, made by Professor Rudolfs, Chief of the Department of Sewage Disposal of the Experiment Station. Professor Rudolfs has been asked by us to explain for the benefit of sewage plant operators just how these conclusions can be applied to every-day operation of tanks, and he has done so in the article below. We feel sure that plant operators will welcome these explanations, which tell them how to make practical application of the latest findings with reference to sludge digestion, as furnishing them with the most valuble information that has rached them for many months.*

In addition, readers of PUBLIC WORKS *are invited to submit questions dealing with the various phases of the results obtained at the Experiment Station and the practical application of them, which Professor Rudolfs will answer from time to time in the form of short articles. These replies will not attempt to analyze, from inadequate description, troubles occurring at different plants, but will be confined to questions dealing with information obtained through the investigations conducted at the Experiment Station insofar as they have reached the point where definite conclusions can be drawn from them.*

A request to discuss briefly some of the methods used in our laboratory and plant studies, and applications of our more recent findings, led naturally into some suggestions as to how sludge digestion tanks can be put into better working conditions and how they can be controlled to a certain extent and the rate of digestion increased. An increase in the rate of digestion naturally means a decrease of time required for digestion or in other words a reduction in the per capita sludge digestion capacity of tanks.

When reference is made to "sludge digestion tanks" it must be understood that this term applies as well to septic tanks and Imhoff tanks as to so called separate sludge digestion tanks. These different names of types of tanks deal only with the construction of tanks, but the fundamental biological processes are essentially similar in all anaerobic digestion chambers. There is no doubt that the construction of a tank, influencing the environment of the sludge to be digested, affecting the manner in which the sludge is being deposited, prompting the introduction of relatively small quantities of air, etc., is of great importance and may be helpful or detrimental to rapid and efficient digestion, but it does not change appreciably the fundamental course of digestion. However, as soon as chemicals are added, large quantities of air introduced, or the sludge is vigorously and continuously agitated, the chemical and physical factors may change the course of oxidation, stabilization or reduction of sludge considerably.

* Chief, Department of Sewage Disposal, New Jersey Agricultural Experiment Station.

DETERMINATIONS OF pH VALUES

During the last five years hydrogen-ion determinations have been made in our laboratory on practically every sample of material analysed. We have employed different methods, namely the hydrogen electrode, color standards and the quinhydron method. None of these methods has been found infallible, but for ordinary practical

purposes the colorimetic method has given good results. Ordinarily our samples are centrifuged in a high speed centrifuge, but in sewage plants where no centrifuge is available the following method will give generally good results. In a funnel of about 5 inches diameter a layer of glass wool is placed and sludge or liquid poured on top. The first three or four filtrates are discarded until a mat of sludge sufficient to act as a filter has been established and the determination is made on the fairly clear liquid. In some instances, when dealing with partly decomposed material, no clear liquid can be obtained. Ordinarily this happens (with domestic sewage) when the sludge is slightly acid. If difficulties of this nature are encountered we will always be glad to be of assistance. Filter paper should not be used, because the paper, which has been treated with an acid and washed with an alkali, contains practically always traces of these chemicals resulting in abnormal $_pH$ values of the filtrate.

Very acid, partly decomposed material has rarely a $_pH$ value below 5.0 and ripe sludge rarely above 8.2. The following colors will cover the range: Brom-cresol-green, Chlor-phenol-red, Brom-cresol-purple, Brom-thymol-blue and phenol-red. Since for domestic sewage the optimum reaction for digestion (mainly liquefaction) is $_pH$ 7.3 to 7.6, and in Imhoff tanks the $_pH$ value usually varies only from 6.2 to 8.2, Brom-thymol-blue and Phenol-red are the only indicators necessary. In separate sludge digestions tanks —when the scheme is followed of filling the tank with raw sludge and letting it stand—$_pH$ values will be lower at the beginning of digestion. Color standards are made in our laboratory but they are on the market ready for use.

SAMPLING

In order to have a fair picture of activities in a digestion tank as indicated by $_pH$ values, samples can be taken from the liquid between scum and sludge or from the sludge. Samples from the liquid should be taken 1 to 1½ feet above the sludge level. Samples from this level show more quickly the trend of digestion (whether in acid or alkaline direction) then samples from the sludge. We use a self closing bottle attached to a pole. In a foaming tank the sludge level can not be found readily, since most of the sludge is dispersed throughout the liquid. In such a case (in Imhoff tanks) we take samples at a depth just below the slots; and if foaming occurs in separate sludge digestion tanks, sufficiently below the possible scum level to avoid a mixture of scum and liquid. ($_pH$ values of the scum are often of interest to the seasoned investigator, but might be misleading for the operator. It often will be found that at the beginning of foaming the scum is decidedly alkaline and later on when foaming progresses just as decidedly acid.)

RELATION OF RIPE SLUDGE AND FRESH SOLIDS

In former publications we have stated our conclusions that foaming in tanks is principally caused by an incorrect relation between ripe sludge and fresh solids. When foaming starts it can be aggravated by the reaction of the tank contents. A correct relation between ripe sludge and fresh solids is another way of saying "a proper biological balance." By a proper biological balance is meant a more or less definite relation of organisms active in digestion in regard to their numbers and activities. If, for instance, a group of organisms responsible for the decomposition of carbohydrate material is all out of proportion to organisms responsible for the digestion of nitrogenous substances, the result might either be an acid tank or a very alkaline tank. Ordinarily very alkaline conditions occur only in places where considerable trade waste of certain character is received or where the water is extremely hard. We will have to deal therefore mainly with acid tanks.

In such an acid tank the organisms responsible for carbohydrate digestion are overbalancing those which attack nitrogenous material, with the result that an accumulation of acid material (organic acids, etc.) takes place. In order to prevent this ultimate result, the fresh solids entering a tank should be kept fairly constant in ratio to the ripe sludge present. We have determined the amounts of fresh solids which can be added, namely 2 parts of dry fresh solids to 98 parts of ripe sludge every day. This means a digestion period of 50 days, disregarding decomposition and shrinkage which affect the sludge capacity. However, when the reaction of a tank is correct or controlled with lime, this digestion period can be reduced to 30-35 days for minimum satisfactory digestion. If no determinations of solids can be made for calculations on a dry basis, 10% by volume of fresh solids is about correct. This takes into account the greater density of the sludge, the shrinkage, etc. Any sewage operator can determine approximately the amount of ripe sludge present. He knows also the amount of solids received at his plant and a simple calculation will show him how much sludge should be present to obtain satisfactory results. In our forthcoming report, calculations are made for minimum sludge capacity necessary under different conditions.

HOW TO KEEP RELATION CONSTANT

How to keep the relation of ripe sludge and fresh solids constant in an Imhoff tank is somewhat more difficult than in a separate tank. The solution for an Imhoff tank is frequent drawing off small quantities of sludge. When once the proper relation between ripe sludge and fresh solids has been established, the operator must calculate the amount of solids received daily at his plant. Assuming that during the summer months half of the organic material is reduced in 30 days, and assuming that the operator has a sludge storage capacity equivalent to 45 days accummulation of undigested and uncontracted material (95% moisture), his storage capacity would be equivalent to about 100 days accummulation of sludge in the various stages of digestion. When a given amount of ripe sludge is present, the operator can calculate how much he can add every day and also when and how often

sludge drawing is required without upsetting the biological balance, keeping in mind that on a dry basis 2% solids can safely be added every day and that this amount can be increased if there is more accurate reaction control. For more details on the calculations, the graphs published by Downes (Public Works, 1923, p. 363 and Trans, Amer. Soc. Civil Eng. 1925, p. 508) will be found helpful. But knowing the amounts of material received and the sludge storage capacity of a tank it will be found simple to calculate the amounts which can properly be taken care of.

Daily additions of raw sludge to separate sludge digestion tanks which are in continuous operation is comparatively easy when ripe sludge is present for seeding. Assume a tank of 10,000 cu. ft. containing 5,000 cu. ft. ripe sludge of 10% solids. Every day 200 cu. ft. fresh solids can be added of 95% moisture. When the tank is full, sludge can be drawn and part of the liquid syphoned off. When the temperature in the tank does not drop too low, this procedure can be carried on indefinitely. Experiments conducted on how much liquid can be drawn and its effect on digestion are ready to be reported upon and will shortly be published.

AMOUNTS OF LIME NEEDED

The amounts of lime necessary for adjustment of fresh solids and material in digestion tanks vary. Materials with the same $_pH$ values and different solids concentrations need varying amounts of lime, and materials with the same solids concentration and different $_pH$ values need amounts of lime which are not in direct relation with the $_pH$ values. In adjusting the hydrogen-ion concentration of any sewage material at least three factors must be taken into consideration: (1) desired $_pH$ value of material to be adjusted, (2) amount of total solids and organic matter, and (3) the characteristics of the particular material under consideration. The last factor can be largely controlled by a careful consideration of the first two and can therefore be neglected. A theoretical discussion of the different factors, methods employed to arrive at the following conclusions, etc. is given in the above mentioned forthcoming annual report.

If a plant is working not too abnormally, it will be found that the amounts of lime to be used for adjustment are small. At Plainfield the sewage is rather stale and has an average $_pH$ value of 7.3. If conditions are well balanced in the tanks the ripe sludge will take care of a *definite* amount of fresh solids. However, it is often practically impossible to control the rate of addition of fresh solids so strictly that the balance is not sooner or later upset. This is especially the case with small plants which receive but little attention. In cases where only little attention can be given, comparative large effective sludge digestion compartments will always be necessary. In case acid waste material or large quantities of mash from illicit distilleries are received, bacterial action is affected, more organic acids are produced, the $_pH$ values are depressed and foaming results unless the acids are neutralized with lime. The $_pH$ determinations of incoming sewage, while giving an idea of how acid or alkaline the incoming material is, does not give a clue to the amounts of lime necessary. All our calculations therefore are based on the $_pH$ values of the material in the digestion chamber.

If we wish to change the $_pH$ value of a given material of any concentration to any other $_pH$ value by adding the amount of lime needed, there are three variables. Curves constructed with three variables are more or less complicated, and since we have found that optimum digestion takes place at $_pH$ values of 7.3 to 7.6, we have constructed a set of curves* (fig. 1) which

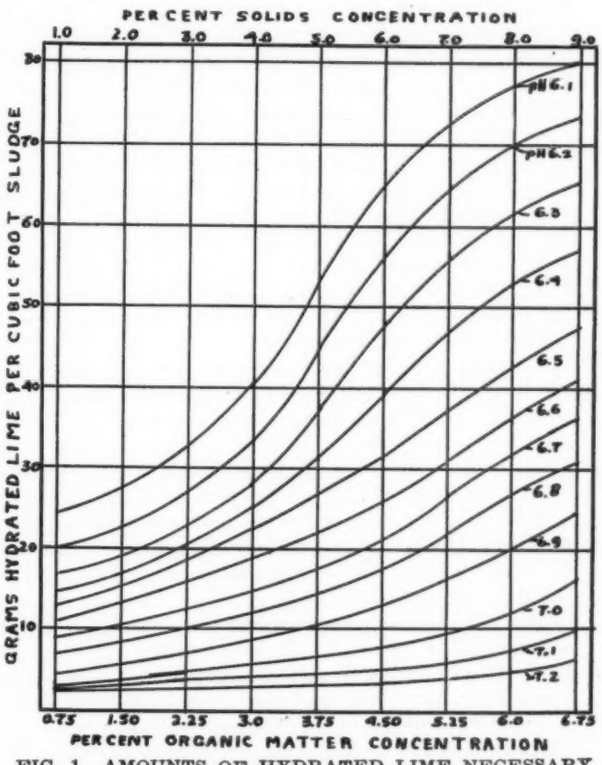


FIG. 1. AMOUNTS OF HYDRATED LIME NECESSARY TO CHANGE THE REACTION OF DOMESTIC SEWAGE SLUDGE TO A pH VALUE OF 7.3. THE ORIGINAL pH VALUES ARE INDICATED ON THE CURVES. (FOR LOWER pH VALUES, FIGURES ARE AVAILABLE.)

shows at a glance the number of grams of hydrated lime to be added per cubic foot of fresh solids or partly decomposed material to adjust the material to a $_pH$ value of 7.3. Ordinarily the amount of solids received at a plant is known. The organic matter content varies only slightly at a given plant. At Plainfield the variations during a year (analyses every two or three days) were not more than 2 or 3% in the settled solids. The total amounts of hydrated lime needed for the Plainfield plant (220 ppm. settleable solids with about 75% volatile matter) are about 3 to 4 pounds per million gallons of sewage daily to adjust the material in the digestion chamber to a $_pH$ value of 7.3. This is the amount needed after the contents in the digestion chamber has reached this figure. If sufficient sludge capacity is present even less or nothing at all is required.

* Mr. A. J. P. Zeller, Junior Chemist, has assisted in making large numbers of determinations on which this curve is based.

But what must be done to correct a poor working, acid foaming tank? Let us take some examples:

1. A tank is foaming but there are still distinct sludge, liquid and scum layers.

First we must find approximately how much sludge and scum is present and ascertain their solid concentrations.

Capacity of digestion chamber	10,000 cu. ft.
Sludge (8% solids)	3,000 cu. ft.
Scum (6% solids)	1,000 cu. ft.
Liquid (0.5% solids)	6,000 cu. ft.
Average solids for chamber	3.3%
pH value of liquid	6.8

When distinct layers are present it will be found that the percentage solids in the liquid is very small, perhaps 0.1 to 0.2%, and the liquid layer can then safely be disregarded. Now let us turn to the curve. With a solids concentration of 3.3% and a $_pH$ value of 6.8 the amount of lime required per cubic foot material is 10.7 grams or a total amount of lime for the whole tank of 220 pounds to change the reaction to 7.3.

2. An aggravated case of foaming.

There is no definite scum or sludge layer but the solids are distributed throughout the tank. All that is necessary is to determine the solids from a sample taken sufficiently deep to insure approximately average conditions, and $_pH$ values determined. Then use the chart for the amount of lime necessary per cubic foot. A simple calculation tells the amount of lime needed for the whole tank.

If more accurate determinations are desired or can be made, it is better to calculate the amount of lime needed on the basis of volatile matter. Because the ash content of different sewages is not alike, especially where industrial wastes are received.

It should be borne in mind that frequent small additions of lime to Imhoff tanks (when required) are far better and more economical than additions of lime at long intervals. In other words, it is easier and cheaper to prevent an aggravated form of foaming than to cure one.

In separate sludge digestion tanks, fresh solids should be added every day. The fresher the solids the more easily they are controlled and the more economical it will be. These fresh solids should be adjusted every time they are added rather than to make an effort to adjust the whole tank when a large amount of fresh solids is accummulated. Separate sludge digestion tanks seeded with sufficient ripe sludge will remain almost indefinitely at the proper $_pH$ value *provided the relation of fresh solids and ripe sludge is kept correct* and the fresh solids are really fresh (added every day as soon as they are settled). None or very little adjustment of the fresh solids will be necessary unless acid industrial waste is present.

If the relation of fresh solids to ripe sludge is correct in Imhoff tanks and the incoming sewage averages about $_pH$ 7.5-7.6, lime will not be necessary unless sudden changes occur like additions of acid trade waste, mash from illicit distilleries, etc. The reason why mash is mentioned in particular is because this material produces large quantities of organic acids in the course of its decomposition. If the average $_pH$ values of incoming material are lower, a constant careful control will prevent a good deal of nuisance and expenditure of money.

Occasionally when a tank is adjusted the fluctuations in the reaction of the material are great and sudden with the subsequent result that biological activities will undergo greater and more rapid changes and in some cases, where the tank was very acid, a possible apparent retardation of digestion seems to take place. It is possible that under certain conditions (comparatively high temperatures or absence of appreciable quantities of ripe sludge, for instance), digestion activities will become so rapid that it at first appears as an aggravation of the troubles. These more violent manifestations of activities, whether desired or not, might at first dishearten the operator but the ultimate result will be beneficial although conditions *ad interim* may not be all what is desired.

METHODS OF APPLYING LIME

It has been the practice at certain disposal plants to dose the influent to Imhoff tanks with lime. Sometimes this has given good results while at other times and places the conditions of the tanks became worse. The reasons are obvious. In cases where conditions improved, the amounts of lime added were just about right to maintain a proper reaction; whereas at others they were either too small or too large.

Additions of lime to the influent is not only wasteful but, if the effluent of the tanks is subsequently thrown on fiiter beds, it might even be harmful; because, while part of the lime added will be absorbed by the finely divided material and carried down through the tank, another part of the lime will remain in suspension and be placed on the beds. Biological activities in the filter beds are, or at least should be, inherently different from the activities in the tanks. The continuous additions of lime to the beds causes a possible partial inhibition of biological activities in the filter and also will cause clogging in the long run.

For the correction of an Imhoff tank we have found that additions of dry hydrated lime to the digestion compartment with the aid of a small pump for mixing it with the liquid, sludge and scum gave good results. The material was pumped out of one compartment into the other and the lime added to the material at the end of the hose with a dry feed mixer. This insured fairly good mixing but this method can easily be improved upon. In some plants perforated pipes are available and milk of lime could be used instead of dry lime. Dumping large quantities of lime into one digestion chamber is not advisable, since the lime will sink to the bottom and cause locally strong caustic concentration with consequent partial sterilization.

For the adjustment of a separate sludge tank a similar procedure can be followed, while adjustment of settled solids which are pumped to the tank can be adjusted at the time of pumping. Sprinkling of lime on top of the scum at fre-

quent intervals is also possible but the reaction of the whole tank, particularly the partly decomposed material lying on top of the sludge, will not receive such rapid benefit and conditions will not be corrected as rapidly and thoroughly.

HEATING THE SLUDGE

Experiments conducted by us and other investigators have shown the importance of maintaining a sufficiently high temperature in the sludge digestion chambers or tanks. The optimum temperature for most rapid and efficient digestion is about 80°F. In actual practice a temperature of about 68-70° F. can easily be maintained without excessive cost. Mr. Downes, supervising engineer at Plainfield, has built separate sludge digestion tanks which have been in operation for some months, to which heat is applied. As was described in a paper recently published in PUBLIC WORKS, last year (a period during the coldest weather) the temperature was raised in a separate sludge digestion tank. From our laboratory experiments we know that maintaining the highest temperature obtained in the tanks during the summer months speeds up digestion markedly. *How* the sludge should be heated is a question which is not settled. Whether it should be done by hot water coils in the tanks, preheating of the sludge or introduction of hot water into the sludge are questions of decided interest and possibly can be settled only by experimentation, but no doubt the sanitary engineer will quickly provide efficient means of heating. One thing is certain—when sludge tanks are heated they must be well insulated, on top as well as on their sides.

Activated Sludge Treatment of Trade Waste

The River Department of the Manchester Corporation, England, has been studying the purification effected by the activated sludge process when dealing with sewage containing dye stuff waste liquor. A preliminary report was published in 1917, and an appendix to this was published by the department for the year ending March 31st, 1926. This describes the tests made and the effect of activated sludge on sewage containing 4 per cent. and 7 per cent waste liquor, respectively, with aeration for periods of four and six hours. The trade waste liquors added to the sewage when making the test were combined from a large number of samples taken at the various outlets of the factories on different occasions.

The conclusions drawn from the experiments were as follows: 1. Waste liquors resulting from the manufacture of dye-stuffs do exercise a slight inhibitory action on the purification process. 2. Notwithstanding this inhibitory action, sewage containing not more than 7 per cent. of these waste liquors may be satisfactorily purified, as viewed from the standpoint of the bio-chemical oxygen demand (Royal Commission test) within a reasonable period of time, although the effluents are by no means free from color.

3. The high four hours' oxygen absorption figures for the effluents obtained when sewage containing this trade waste is under treatment is due to the presence of unoxidized constituents of the trade wastes rather than to imperfect oxidation of the actual sewage organic matter, and the same applies to the somewhat high albuminoid ammonia content of the effluents. 4. It is probable that the differences observed under the condition of these experiments would be accentuated on translation to the working scale, where it is scarcely possible to reproduce such ideal aeration and admixture of the sludge and sewage as obtains in the small scale under careful supervision in the laboratory.

Pumping Trenton Sewage

For pumping sewage in connection with the sewage treatment plant of Trenton, New Jersey, electric power with semi-automatic control is employed. Three 60 horsepower squirrel cage and three 75 horsepower wound rotor 2200 volt, 60 cycle vertical motors driving centrifugal pumps are controlled by a single float in the pump well. At each one inch increase in level in the pump well the speeds of the pump motors are changed or signals given to the operator to start or stop additional pumps. Starting with a minimum capacity and one wound rotor-driven pump it is automatically brought up to full speed, then for additional capacity a signal is given for the operator to start a constant speed motor. When this has been started the wound rotor motor is automatically slowed down to the proper speed and then again brought up to full speed with further increase in sewage flow. At this point a second constant speed motor is started by the operator, the previous cycle is repeated and a third constant speed motor started and later the second wound rotor. For decreasing flow in sewage, the operations are reversed. It is not necessary for the operator to do any special switching to change the sequence of the pumps so as to keep the wear on them the same. He simply starts the pump he wants to use and the control does the rest. This special equipment was furnished by the Westinghouse Electric & Mfg. Co.

Sheffield Street Notes

The city of Sheffield, England, after trying the painting of white lines and several other methods on the roadways for guiding traffic, has adopted stainless steel studs manufactured in that city. Although the first cost of these is greater than that of painting, in the long run they are more economical than repeated renewals of the paint, according to W. J. Hadfield, city surveyor of Sheffield. He considers them quite effective and states that they show up in weather when a painted line could not be seen for any distance.

English cities seem to be troubled with a continual opening of trenches in streets, as do American ones. Sheffield during the fiscal year 1925-26 gave 9,096 permits for opening trenches in its streets, the total length of which is 397 miles.

Nineteen of these applications gave a total length of opening of 7¼ miles, while 64½ miles were opened for electrical mains. Many hundreds of trenches were saved during the year by the use of boring machines for boring holes under the roadway for inserting pipes, of which three machines are now in operation. In order to minimize the number of openings of trenches, conferences have taken place with representatives of other committtes and of public utility undertakings.

Costs of cleaning Sheffield's streets were reduced last year to about $635 a mile, about $20 a mile below the previous year. This brings the cost almost to pre-war figures. The reduction is chiefly due to improved methods, especially the introduction of mechanical appliances; and to improved surfaces which produce less mud and are easier to clean. During the year the city purchased three pickup sweepers and it is expected that during the current year these will permit a reduction in the cost of picking up and removing the sweepings. The city now has seven vacuum catch basin cleaners at work cleaning 7,000 to 8,000 catch basins a week. This is considered a much more efficient method than the old one of emptying the contents of the basin upon the surface of the streets and then shoveling it into carts.

Handling Traffic During Street Construction

In discussing this subject for the League of California Municipalities, J. C. Albers, city engineer of Beverly Hills, told of paving what was known as Whilshire Boulevard without interrupting the traffic on same. This was done by building one-half of the boulevard at a time, the other half being kept open continuously, and all bidders had their attention drawn to this requirement. He reported that the prices were a trifle higher than if the boulevard was to be closed to traffic for five months. The work covered something over 2½ miles and at the time he wrote the paper had been about 35 per cent completed.

The work included lowering a six-inch oil line on the south side of the street, and the changing of the gas mains to the north side so that the street would not have to be torn up for service connections. Immediately following this a 48-inch storm drain was laid on the north side of the street, while at one point a pedestrian tunnel was constructed, one half at a time. Construction of the tunnel required changing the location of portions of the gas and water mains and changing the grade of the sewer and curving the storm drain around the south side of the pedestrian tunnel.

Meantime a curb and gutter crew was putting in combined curb and gutter wherever and whenever it could get a run for a few blocks and at the time of writing 90 per cent of the curb and gutter had been completed. A conduit was also installed for an ornamental lighting system, this being put in the day following the pouring of the curb, while a conduit for traffic signals was installed prior to the laying of the pavement and sidewalk. Installation of lighting standards is to follow the improvements. The laying of the pavement proper, which is to be of concrete, was the simplest part of the whole job. It was laid in three sections, the south portion being poured first, then the north portion, and lastly the center. The roadway is 70 feet from curb to curb.

Mr. Albers states that three major points are necessary for keeping a trunk boulevard open, these being: "(1) To allow traffic to follow the regular line of travel which it has always been accustomed to, especially fire and police cars. (2) To allow the different classes of business operating on the thoroughfare to at least carry their overhead. I have made a brief canvass of the business places operating on Whilshire Boulevard and the heaviest losers are the produce dealers; they claim their business is about one-half, but all other lines of business are normal, and I dare say we have had only a few complaints in blocking gas stations for about sixty hours during the placing of the storm drain. (3) The last and most vital is, as the new concrete work on curb and gutter is bridged, not to detour on light residential streets which are in most cases 5-inch concrete or 4-inch macadam and sometimes lighter; it first ruins these streets which are rarely ever repaired unless a permanent improvement is done on the detoured streets. There is also the dust that is whipped up by the traffic; and lastly is the factor of safety, especially in a residential district where children and pedestrians are not accustomed to the increased traffic."

This boulevard is carrying at least 10,000 cars a day. It was policed during construction by four policemen, two on motorcycles for through traffic and two directly under the engineering department to assist traffic around the steam and gas shovels and to direct trucks loading and unloading.

Mr. Albers did not believe that this method is advisable unless a street is 50 feet or more between curbs.

Baltimore's Incinerator Operation

A refuse incinerator for the city of Baltimore located at 28th and Sisson streets was put into operation on November 25th, 1924. Figures for the complete year 1925 have recently been made public and these show that the net cost of operation for the year was $7,492. The total cost of operation was $31,655, while the revenue from salvaged material was $24,163.

The material salvaged included 2,713,809 pounds of paper, which brought a revenue of $12,360; 169,984 pounds of rags sold for $4,457; 1,059,339 pounds of baled tin cans sold for $2,787; 425,730 pounds of bottles and 274,145 pounds of broken glass sold for $3,433; 35,144 of miscellaneous metals brought $713; 12,498 pounds of miscellaneous rubber sold for $208; and 79,308 pounds of shoes and old leather sold for $206.

The Bureau of Street Cleaning, of which William A. Larkins is chief, has charge of the operation of this plant.

PUBLIC WORKS

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More Consideration Needed of Low-Cost Highways

Eighty-five percent of the roads of the United States are earth roads, and more than two-thirds of the Federal Aid roads completed to date are dirt, sand-clay and gravel. But if we examine the papers presented at national conventions and published in technical magazines of national circulation we find perhaps eighty-five percent of them devoted to asphalt, concrete and brick pavements, and most of the remaining fifteen percent to various general topics such as location and drainage.

For several years past we have endeavored to do our bit in supplying this lack by publishing such informative material on the subject as we could obtain; and in preparing for this issue we asked the state highway officials of the states where the mileage of such roads exceeds that of all the more expensive kinds to contribute to a symposium on the subject. A number have done so. Many of the others may feel, as one of them expressed it, "that we are woefully deficient in experience and information on this topic, and will certainly welcome a symposium of descriptions and methods employed in states that began early to give the matter attention. We regret very much that our lack of experience and information prevents this department from taking part in this discussion, but the magazine containing the discussion will certainly be awaited with great interest."

There are no better riding roads than dirt and gravel when they are well maintained and neither dusty nor muddy. How to keep them in this condition under the various climatic and topographical conditions to be found from Maine to Florida, Washington to Arizona, and all in between, is a subject demanding a great deal more trained investigation by our highway experts than it is receiving.

Public Works' Associate Editor

It gives us pleasure and satisfaction to inform our readers that we have added to the editorial staff of PUBLIC WORKS as Associate Editor W. A. Hardenbergh, who was on our editorial staff from 1914 to 1917, when he left to serve in the war; having previously graduated from the engineering course of Union College and spent two years on hydro-electric surveys.

He was assigned to the Public Health Service and was engaged in extra cantonment sanitation during the war and in research in sewage disposal for two or three years. At present he is Major, Sanitary Reserve Corps, U. S. Army and president of the Ninth Alabama District Reserve Officers' Association. Since 1921 he has been director of the Bureau of Sanitary Engineering of the Jefferson County (Alabama) Board of Health and director of rural sanitation, Birmingham, Ala., during which time the typhoid case rate per 100,000 has been reduced from 244.4 to 55.0

His writings include "Home Sewage Disposal,"

published by J. B. Lippincott Co.; numerous articles on sewerage and water supply in trade journals and the American Journal of Public Health; and the re-writing and revision of the International Correspondence School's text books on water supply, water purification, sewerage and sewage treatment. His experience as both engineer and writer will aid us greatly in producing an engineering and construction journal of the highest type.

Federal Aid Road Work

The Federal aid road projects completed during the fiscal year 1926 added 9,417 miles to the improved roads of the Federal aid system, according to the annual report of the Bureau of Public Roads. This brings the total length of improved Federal aid roads up to 55,902 miles. At the close of the year construction was in progress on 10,962 miles and projects involving the improvement of 2,469 miles additional had been approved. This gives a total of projects improved or in process of improvement with Federal Aid as 69,334 miles. The total mileage selected by State and Federal highway officials for Federal aid totals 182,134 miles. Considerable work has been done on parts of this system by the States without Federal aid, so that nearly three-fourths of the mileage has been initially improved. Much improvement, however, has been of low type roads such as graded earth, sand-clay and gravel, and will have to be improved to a higher type as traffic increases and makes this necessary.

Status of Federal Aid Highway Construction

Fiscal Year 1927

States	*Projects Under Construction Estimated cost	Federal aid allotted	Miles	Projects Approved for Construction Estimated cost	Federal aid allotted	Miles	Balance of Federal aid fund available for new projects
Alabama	$4,036,643.28	$1,865,385.81	131.4	$307,154.54	$153,577.27	19.9	$3,111,590.48
Arizona	1,365,684.79	944,542.22	68.8	82,189.48	50,225.99	12.2	2,586,703.70
Arkansas	4,364,161.43	2,065,766.25	282.0	897,052.81	443,831.94	87.9	1,250,503.74
California	12,159,380.20	5,922,687.78	321.3	717,759.37	416,237.89	12.3	2,643,275.51
Colorado	4,716,491.19	2,279,078.52	230.0	500,176.37	276,344.35	35.1	2,406,985.61
Connecticut	4,140,337.20	1,087,698.03	59.2	589,473.04	259,391.25	4.2	886,005.92
Delaware	1,115,536.81	470,577.90	28.2	623,535.35	218,310.90	15.7	3,503.60
Florida	8,702,382.31	4,034,437.58	247.9	241,489.11	119,798.25		1,617,292.56
Georgia	12,133,040.41	5,953,775.80	625.7	827,784.58	356,571.17	20.2	107,537.40
Idaho	2,963,163.97	1,800,754.40	177.8	792,108.22	459,819.38	71.5	267,041.59
Illinois	7,501,516.63	3,627,458.88	263.3	657,378.09	302,879.03	21.0	4,300,903.69
Indiana	17,579,418.96	8,289,152.68	505.5	281,117.68	140,558.84	7.2	811,455.34
Iowa	11,918,971.28	5,737,713.15	733.1	2,930,081.42	1,326,666.32	119.0	308,074.38
Kansas	12,379,069.79	4,824,178.50	666.9	2,715,366.74	1,009,919.23	144.5	837,419.95
Kentucky	6,684,243.21	3,219,303.43	336.4	560,491.27	279,745.62	23.6	1,115,290.87
Louisiana	3,497,782.62	1,697,567.74	161.3	1,346,845.99	619,114.94	47.3	810,985.33
Maine	2,364,417.18	854,849.24	67.3	1,456,698.19	610,367.98	50.2	807,103.39
Maryland	513,398.28	252,643.43	30.8	1,263,113.28	559,420.86	57.7	1.49
Massachusetts	4,807,818.26	1,284,622.27	66.1	1,174,386.11	311,928.55	19.0	1,832,204.51
Michigan	11,635,732.67	5,332,933.17	318.1	1,034,498.96	440,238.19	23.6	2,553,424.30
Minnesota	8,004,732.22	3,003,100.00	387.2	477,555.12	36,000.00	16.1	144,804.37
Mississippi	6,865,002.79	3,401,331.84	379.0	1,321,827.50	592,714.92	49.1	425,405.58
Missouri	18,107,810.63	7,230,468.54	505.5	450,972.41	202,106.41	7.5	354,778.84
Montana	2,360,606.34	1,856,271.18	160.7	982,999.25	580,430.98	112.2	4,520,264.56
Nebraska	13,456,039.51	6,644,568.45	1,397.9	868,508.28	410,550.09	121.2	1,899,703.40
Nevada	2,214,266.87	1,894,315.49	274.1	41,715,60	36,592.91		670,603.22
New Hampshire	1,339,869.53	601,785.70	39.3	38,717.88	29,092.93	0.1	161,163.30
New Jersey	8,295,562.92	2,763,486.67	48.1	1,441,354.16	289,789.17	18.1	252,316.19
New Mexico	1,883,157.63	1,241,284.96	123.0	552,060.36	413,314.99	56.0	1,978,128.67
New York	35,030,973.00	9,446,955.20	597.2	8,723,050.00	1,900,000.00	118.0	4,109,886.43
North Carolina	4,970,040.28	2,268,851.50	132.6	972,106.70	456,189.10	40.5	401,935.69
North Dakota	7,747,244.18	4,044,457.00	979.1	1,141,361.65	587,665.63	178.2	1,778.91
Ohio	12,181,657.75	4,672,653.58	353.8	3,438,761.00	1,178,882.13	96.1	2,043,621.39
Oklahoma	2,613,646.38	1,215,306.60	101.8	1,285,313.86	606,754.67	96.7	865,432.46
Oregon	3,238,079.35	1,770,139.62	113.2	238,968.69	143,381.21	13.3	171,311.76
Pennsylvania	27,087,825.96	7,711,872.53	550.1	2,407,226.26	731,213.01	47.6	1,334,963.42
Rhode Island	1,282,981.70	340,980.00	22 7	743,891.14	201,195.00	13.4	480,389.94
South Carolina	5,914,916.16	2,726,699.15	204.4	155,548.99	50,921.58	19.9	9,792.06
South Dakota	3,843,913.49	1,936,835.85	639.1	596,224.95	313,144.19	99.6	170,111.98
Tennessee	8,873,923.50	3.952,348.28	253.1	739,242.79	328,777.17	19.0	694,897.93
Texas	18,511,166.40	8,182,775.90	864.2	2,477,214.12	1,130,036.92	61.5	3,584,397.99
Utah	1,760,452.52	1,330,318.86	158.1	864,739.48	658,542.65	53.5	678,191.94
Vermont	2,098,553.60	812,423.54	39.0	51,449.37	13,905.01	0.8	424,478.94
Virginia	6,431,746.40	2,750,981.14	186.4	138,973.67	68,172.20	2.6	58,503.94
Washington	3,294,245.95	1,630,600 00	43.5	1.008.163.90	374,000.00	43.7	256,624.05
West Virginia	4.805,344.41	1,869,689.67	124.7	1,594,741.81	709,692.13	62.8	438,370.14
Wisconsin	8,154,614.98	3,927.945.62	376.2	742,702 15	339,241.00	25.2	2,728,257.94
Wyoming	2.842,290.94	1,795.908.53	213 8	112,844.59	84,159.81	24.3	427,129.61
Hawaii	1,050,897.93	312,635.18	15.9				787,517.82
TOTALS	358,840,753.79	152,882,117.36	14,604.9	52,606,936.28	20,821,413.75	2,189.1	58,332,065.83

* Includes projects reported completed (final vouchers not yet paid) totaling: Estimated cost $89,526,921.22 Federal aid $38,486,599.58. Miles 3,457.4.

Reports on Highway Research

Summaries of reports presented at the Sixth Annual Meeting of the Highway Research Board on economic theories and structural design of roads, character and use of road materials, highway finance, traffic analysis, and road maintenance.

COMMITTEE ON ECONOMIC THEORY OF HIGHWAY IMPROVEMENT

Chairman, T. R. AGG, *Iowa State College*

Tire wear investigations at State College of Washington.—Following conclusions may be drawn from the data now available:

1. Tire wear increases with the speed of the vehicle.
2. An increase in the rate of wear appears to accompany the higher temperatures.
3. The rear tires wear more rapidly than the front tires. The relative rate of wear on the rear tire ranges from 119 per cent to 200 per cent of that on the front tires and averages about 150 per cent.
4. Tire wear is probably consistent for any given road surface when the size of tire, the load hauled and the inflation pressure on the tires are measured by the same standards.

The economic significance of the results are shown in the following table:

Road surface	Index No.	Computed tire mileage	Annual tire cost per car for 6,000 miles per year	Cost of tires per vehicle mile	Annual cost per mile of road per 100 cars per day	Tire operating cost capitalized at 5 %
Concrete, average	1.0	22,750	$31.65	$0.00533	$190	$3,800
Bitulithic	0.95	24,000	30.10	.00502	180	3,600
Brick, average of all	1.4	16,250	44.30	.00738	266	5,300
Macadam, best	1.9	12,000	60.10	.01002	361	7,200
Gravel, typical Iowa	2.0	11,375	63.30	.01055	380	7,600
Bituminous macadam, best	2.3	10,000	72.80	.01213	437	8,700
Macadam, average	4.4	5,175	139.40	.02323	836	16,700
Gravel, uncrushed chert	5.0	4,550	158.25	.02637	950	19,000
Bituminous macadam, poor	9.6	2,375	302.00	.05033	1,728	34,600
Macadam, loose	11.0	2,050	316.00	.05267	2,090	41,800

Investigations of rolling resistance and power consumption of motor vehicles at North Carolina State College.—A special report on these investigations will be presented at the Sixth Annual Meeting.

Investigations of wind resistance at Kansas State Agricultural College.—Since report at Fifth Annual Meeting, this project has been operated to clear up doubtful points. A complete report is now being published.

Economic studies at Iowa State College.—These include:

1. Rolling resistance. Roughness of road surface increases rolling resistance at lower speeds; at very high speeds it is lower on rough roads than on smooth.
2. Air resistance.—Data from Kansas tunnel experiments may be applied directly to tractive resistance determinations made by deceleration method to calculate air resistance.
3. Effect of grade on fuel consumption.—Additional data since report at Fourth Annual Meeting is being presented.
4. Coefficient of friction between tires and road surfaces.—Includes first comprehensive measurements of force required to cause side skidding. Coefficient of friction between pneumatic tires and clean and dry road surfaces lies between 0.625 and 0.925; on road surfaces coated with snow or ice, or with oily slime or with mud, as low as 0.25 for wet surfaces and 0.15 for icy surfaces that are thawing a little.

COMMITTEE ON STRUCTURAL DESIGN OF ROADS

Chairman, A. T. GOLDBECK, *National Crushed Stone Association*

Subgrade investigations.—Vertical displacement of pavements up to 0.265 feet occurred in Ohio in 1925-1926.

The slaking test promises to be of considerable assistance for determining when and how to protect pavement shoulders.

Moisture content in heavy clay soils at depths of 6 inches to 2 feet is not largely affected by long or heavy rains but is increased by snow blanket. Average annual moisture at these depths is slightly less than moisture equivalent.

Porous sub-base tests in Ohio show 1.29 feet of crack for each lineal foot of concrete road on the natural soil and from 0.45 to 0.74 foot on various porous sub-bases after two years of service.

Field subgrade studies.—A method is proposed for correlating pavement condition with subgrade characteristics.

Settlement of fills on peat marshes.—Settlement can be estimated from soundings giving depth of peat and lacustrine clay. To save earthwork, narrow fills should be forced into the peat to as great a depth as possible to compress peat on both sides before embankment is completed.

Top-soil road investigations.—A review of studies of 29 Georgia Federal Aid projects is presented.

Impact studies.—In impact due to motor trucks that from unsprung weight is generally greatest. Tire equipment which permits of longer time reactions causes lower forces. Increase in wheel load, speed and road roughness cause larger reactions. Six-wheel truck reactions approximate one-half those of four-wheel trucks.

Paving brick studies.—Properly supported paving brick 2 1/2 inches thick are satisfactory for heavy traffic and brick 2 inches thick are adequate for lighter traffic. Thin sand bedding course not over 3/4 inch thick gives best results and is preferable to cement-sand bedding course.

Bituminous macadam road design.—Fundamental precautions for successful bituminous macadam pavement design and construction are discussed in the light of field observation.

Concrete pavement design.—1. *Curing tests for concrete.*—It is indicated that the most important requisite for satisfactory curing is to protect the concrete from drying out during the first 24 hours after placing.

2. *Planes of weakness.*—Indications are that planes of weakness are an economical and satisfactory method of localizing and controlling transverse and longitudinal cracks in concrete pavements.

3. *Analysis of effect of natural forces on concrete pavements.*—Stresses in concrete pavements due to causes other than loads have been investigated. These include curling due to change of temperature and blowup due to lack of provision for expansion.

4. *Reinforcement.*—One of the effects of reinforcement of the mesh type is to add approximately 10 per cent to the extensibility of the concrete, both in ordinary static loading and in fatigue loading based on eye visible first crack. When based on first microscopic fissure, the increase is about 3 per cent.

COMMITTEE ON CHARACTER AND USE OF ROAD MATERIALS

Chairman, H. S. MATTIMORE, *Pennsylvania State Highway Department*

Review of alkali action on Portland cement concrete, cause and prevention.—Investigations to date indicate that carefully made, well cured concrete, rich in cement and of high unit strength and low permeability best resists attack. Admixtures, as a rule, have not proven beneficial. Surface coatings apparently have some possibilities. A considerable difference in resistance among Portland cements has been noted.

Concrete and concrete aggregates.—Several laboratories are using the repeated freezing and thawing tests, and two are studying other types of accelerated tests for aggregates.

Attention is called to the rapid growth in the use of the cross-bending test as a method of field control ovevr the transverse strength of concrete for road construction. The desirability of ascertaining the effect of shape and surface condition of the constituent aggregate particles on the strength of concrete seems a very important problem to the committee.

Field control of concrete making.—The field practices of several organizations in charge of concrete work of great magnitude take full cognizance of the effects of the "water-cement ratio" upon the strength of concrete, and of the size and grading of particles upon economical design. The advantages of measuring granular materials by weight are becoming extensively recognized, and the "Inundation" method for measuring sand is being used. The methods employed by several large organizations are reviewed in this report.

Bituminous paving mixtures.—Attention is still largely focused upon the development of a test for stability, although the ultimate object is the formulation of a rational theory of design. Effects upon stability of such factors as type and fineness of several fillers, and the per cent and consistency of bitumen have been studied in the laboratory. The significance of voidage of aggregates has received attention, and the definition of a reliable test for voids is the object of research under way by several organizations.

Materials for surface treatment.—Keen interest is being evinced in materials involved in the surface treatment of gravel and earth type roads. Correlated service and laboratory tests are being conducted in several States with bitumens of widely different characteristics employed under conditions of the greatest dissimilarity.

Subgrade materials and tests.—It is agreed that the clay content is one of the major factors affecting the stability of subgrade soils. Admixtures of different kinds of materials have been used to stabilize clay soils. Reports on these experiments indicate that finely ground materials, such as hydrated lime and Portland cement, are not as efficient for this purpose as coarser granular material of the character of sand and stone screenings. There is urgent need for a uniform classification of subgrade soils and adoption of standard methods for laboratory and field tests.

COMMITTEE ON HIGHWAY TRAFFIC ANALYSIS

Chairman, G. E. HAMLIN, *Connecticut State Highway Commission*

Planning for arterial highways outside of congested areas, including belt lines for detouring large centers.—A uniform width highway is neither necessary nor desirable unless the distance between points of congestion is comparatively small. Provision for widening the principal arterial highways is not alone sufficient. Further relief must be afforded by belt lines.

Use of highways for interstate travel.—Analysis of foreign car traffic shows that a large part of interstate travel is in the border counties and is, strictly speaking, local traffic. As a measure of long distance interstate travel, the important figures are the percentages determined for interior counties.

Carrying capacity of highways as affected by width of surface and restrictions of use.—An unrestricted speed limit may be considered in the near future an argument to decrease traffic congestion. The State highway department responsible for the State highway system should be responsible for the control over State highway traffic and enforcement of State highway traffic regulations.

The committee recommends that highways be classified in terms of weight-carrying capacities.

The relation between volume of traffic and population and the relation between volume of traffic and industries served.—It is believed that the influence of industrial development will continue to affect the ratio of traffic to registration, and that the ratio

of population to registration, at the so-called saturation point, will reflect the density of population.

The large vehicle and the heavy wheel load including the semi-trailer and the six-wheel bus.—Long hauls by trucks are very rare and represent a very small part of total truck movement. Obviously the extra expense entailed in building the pavement adequate for the larger trucks cannot be justified.

Classification of highways in reference to right-of-way as functions of traffic volume and kind.—Traffic volume is largely a function of population density, so that there will be different traffic divisions on the same route. The estimated future traffic is the important consideration. Provision should be made for acquiring additional right-of-way widths before property increases so largely in value as to add unduly to the cost of future improvevment.

Selection of type by traffic.—The traffic volume has a determining influence in the selection of the general class of pavement, and the economic factors determine largely the choice of type within the groups.

Planning the improvement of state highway systems.—The various sections of a highway system selected for improvement and the types of improvement selected for construction on each section of a highway system should be based upon present and expected future traffic demands. The budget system should be followed in planning expenditure of highway funds.

The principal function of a highway transportation survey in planning a program of highway improvement:—

1. To measure present and predict the future volume and character of traffic on State systems.
2. To determine the relationship between population and demands for highway service.
3. To classify highway routes or sections of routes.

COMMITTEE ON HIGHWAY FINANCE

Chairman, H. R. TRUMBOWER, *University of Wisconsin*

Receipts from motor vehicle registration fees.—The 1925 data and reports show that in 34 States the collection and administrative expenses amounted to 5.6 per cent of the amount of fees received. These expenses averaged 70.4 cents per motor vehicle registered. After deducting these reported collection costs it is found that 71.5 per cent of net license fee receipts is devoted to the construction and maintenance of the State highway systems, and 19.5 per cent to the construction and maintenance of local roads; 7.7 per cent is used to meet interest and principal payments on State and local highway bonds; the remainder is used for various purposes. The report contains the statutory provisions relating to the division and disposition of these fees by each of the States. The motor vehicle license fees furnished over one quarter of the funds expended by State commissions for highway purposes.

Receipts from the gasoline tax.—The 28 States reporting on refunds of taxes paid on the sales of gasoline used for other than for highway purposes show 4.1 per cent of the gross amount collected was disposed of in this manner. The collection costs amounted to $2.64 per thousand dollars collected. This cost may be compared with the cost to the Federal Government of $22.50 per thousand for the collection of customs duties, and $12.10 per thousand for collecting internal revenues. Sixty-seven per cent of the net collections was devoted to the construction and maintenance of State highway systems; 22 per cent was diverted to local highway use; and 4 per cent used to meet highway bond requirements. Eighty-nine per cent of the gasoline tax money and 91 per cent of the license fees was used for the construction and maintenance of highways, State and local. The gasoline tax furnished substantially 12 per cent of the funds used for highway purposes by the State commissions. For local road improvements the gasoline tax contributed about 4 per cent of the total costs, whereas the local share of the license fees constituted somewhat over 8 per cent of the local expenditures. The method of gasoline tax revenues followed by each of the States is also set forth in the report.

The total disbursements for rural highway purposes in 1925 by both State and local authorities was $1,288,000,000; the total license fees and gasoline taxes was $407,000,00, or about 32 per cent. It is estimated that for 1926 the motor vehicle revenues will be close to $500,000,000. In 1921 the total motor vehicle revenues amounted to only $128,000,000, and the total highway expenditures were approximately a billion dollars. Since then the motor vehicle revenues increased about 220 per cent; the highway expenditures approximately 28 per cent. The motor vehicle registrations increased during this period 99 per cent.

COMMITTEE ON MAINTENANCE OF ROADS

Chairman, W. H. ROOT, *Iowa State Highway Commission*

Maintenance of concrete pavements.—So far as practicable, repairs should be made with quick setting cement concrete. This involves a rich mixture, the use of a minimum amount of water, thorough mixing, the admixing of calcium chloride and and the making of repairs in warm weather. If cement concrete is impracticable, bituminous materials may be used. The cause of failure should be ascertained and removed before repairs are completed. Construction inequalities in the surface should be removed at once to insure a good riding surface.

Snow removal and snow equipment.—During the winter of 1925-26, 93,000 miles of highways in the United States were kept clear of snow at a cost of $3,757,660. This is an increase in miles cleared of 50 per cent over the preceding winter. Snow fences are employed in all sections where drifts are encountered and are reported effective. Straight blade and "V"-type truck plows are favored for "keeping the roads clear of snow." Heavy tractor plows are used in "opening roads" and for widening snow cuts. Relative costs of snow removal have been studied, but due to varying conditions reliable data cannot be reported.

Coverings for poorly constructed and disintegrated concrete roads.—In general, the demand for a new surface is not because the sustaining power of the old slab is insufficient, but because the old surface is so rough as to make it uncomfortable to ride over. One of the most difficult problems to solve in a resurfacing job is to fill low places so as to produce a uniform cross-section true to profile before the new surface is put on. Bituminous types may be used with success if the base is properly evened up before the top is applied. Ohio has resurfaced with 4-inch and 5-inch concrete slabs with satisfaction. Indiana is just starting an interesting experiment near Indianapolis, where seven different types of surfaces are being tried.

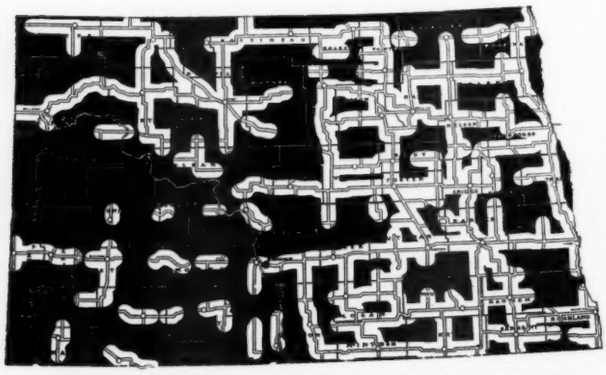
Determination of annual reduction in thickness of gravel roads under different traffic and the effect of dust palliatives.—A study of 236 miles of untreated gravel road over a period of three years in Indiana, indicates that with their material and under their traffic the annual wear resulting from an average traffic of one vehicle per day is 0.289 cubic yards.

Area Served by North Dakota Highways

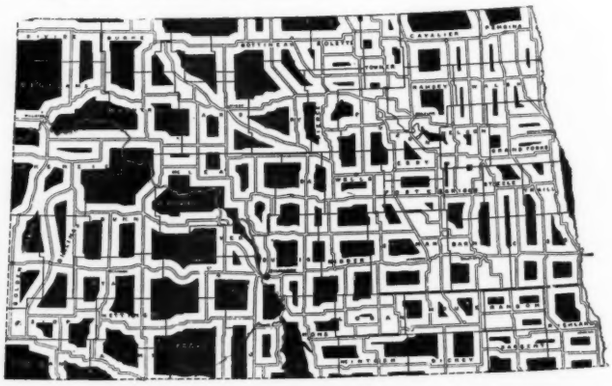
The State Highway Commissioner of North Dakota has published in the "North Dakota Highway Bulletin" two interesting maps, one showing what area of the state is now being served by the highways which have been improved and another showing the area which will be served by the State Highway System as planned. The white spaces show the territory which is within five miles of a state road, this limit of five miles being fixed arbitrarily as a fair distance from such an arterial highway as is furnished by the State Highway System.

According to the 1920 U. S. census there is 70,183 square miles of land area in North Dakota, no allowance being made for water in streams or lakes. Of this area 16,371 square miles, including land and water, lie more than five miles from the road included in the State Highway System, or only 23.3 per cent of the entire state. If the streams and lakes had been included in the U. S. census figures it would be fair to state that only one-fifth of the state is more than five miles from a state road. It is believed that there is over 106,000 miles of state, county and township roads, of which there will be 7,343 miles in the completed state highway system. This leaves nearly 100,000 miles of county and township roads which, undoubtedly, serve considerable of the area which is shown in black on the map.

In the map showing the territories served by the highway systems completed to date, 36,216 square miles are shown as more than five miles away from the completed road, which is 51.6 per cent of the land area of the state.



AREA SERVED BY PRESENT IMPROVED STATE HIGHWAYS.



AREA THAT WILL BE SERVED BY STATE HIGHWAY SYSTEM WHEN IT IS FULLY IMPROVED.

Research Activities of the Michigan State Highway Department

By V. R. Burton*

The major project of research at present under way in Michigan is a study of the various designs of pavement and pavement drainage used in the past, taking into account the character of the soils in which they are laid. It was the thought of the Department heads that the work done previously should constitute a great outdoors laboratory which should show much more truly the performance of different designs under various conditions than could any set up of the more or less artificial conditions necessary to an experimental road. The collection and classification of this information is being handled through the agency of a pavement survey and soil survey at present in progress.

Certain facts have been determined already. A study of a number of "sink holes" in peat marshes has radically changed the policy followed in handling situations of this kind. It was the former practice to load these peat marshes as lightly as possible to avoid settlement. The study made demonstrated the fact that settlement is bound to occur anyway, and the logical policy to follow is to encourage rapid settlement by heavy loading so that the fill may be stable when surfacing is placed. New methods of placing these fills have been worked out which insure material savings in earthwork besides producing a stable embankment.

The curing of cement concrete pavements by the surface application of calcium chloride has been investigated in both field and laboratory. The results obtained have led to the abandonment of the use of this method of curing due to

*Engineer on Special Assignments.

.ts tendency to accelerate surface scaling. The use of this chemical as an integral admixture is at present being investigated. Standard test cylinders and beams are being made on a paving job and the strength increases over various curing periods and at various temperatures noted. The effect on the surface of this method of curing will also be investigated, as this effect is considered fully as important as the beam strength of the concrete.

A preliminary study of underdrainage has shown that tile underdrain, either with or without gravel sub-base, when installed at a good depth along the edge of the pavement slab, is very effective. On one project built two years ago on one of our heaviest traveled roads, stretches of pavement are in perfect shape with no other cracks than the 100-foot joints for as long as a half mile at a time. This sub-grade of heavy clay was treated with gravel and sand sub-base and edge tile, and was considered so difficult by the county highway authorities that it was claimed no rigid pavement could be built on it. Sub-base, unless thoroughly drained with tile, has been demonstrated to be worse by far than no sub-grade treatment at all.

The cause of frost heaves in pavement has been investigated and, for those investigated at least, has been shown to be due to radical changes in soil texture. This work will be carried on through the coming winter and the effect of measures to prevent this heaving which have been installed during the past summer observed.

Very interesting experiments with snow fence have been planned for this coming winter. It is planned to investigate the effectiveness of various types of snow fence for standard heights, the effect of height of fence on the length of drift formed and also the proper spacing of pickets for the picket type and boards for the board type. A complete meteorological station has been erected to give data on drifting conditions as influenced by wind and sunshine. The amount of snow reduction due to temperature and sunshine will also be studied.

No data of any kind on this subject are available so far as is known, and for Michigan this subject is an important one. It is confidently believed that a liberal and intelligent use of snow fence will permit of the substitution of light fast-moving equipment for the heavy tractor plows now necessary. This will not only give cheaper costs but a service which is incomparably superior*.

A number of research projects are being carried on at the State Highway Department Laboratory. The effect of non-standard cement on concrete, the relation of the results of the 7-day mortar tensile test to the 28-day—if any, the effect of the height of mixing table on the strength of mortar briquettes, the effect of cross-section variations in the tensile strength of mortar briquettes, etc., are all being gone into.

Last winter the effect of the use of calcium chloride for surface curing on the surface of concrete was thoroughly investigated by the laboratory. The results of this investigation checked the field studies previously referred to and as a consequence the use of the material in this manner was discontinued.

A laboratory study of the expansibility on freezing of soil separates with varying water contents has just been started, and will be carried on through the winter. Considerable information of interest to those engaged in subsoil study should result from this work. It is very little understood by engineers in general that a considerable portion of the water held in certain soils will not freeze even under very low temperatures and that actual water content is no measure of the expansibility to be expected.

The research work on soils will necessarily take a considerable period of investigation before results will be at all complete. It is highly probable that this work will extend over several years before complete classification can be effected. About 500 miles of pavement were covered this summer and the data will be worked up during the winter. Considerable preliminary information should be available by the spring of 1927.

*See also article in this issue on "Snow Drift Prevention."

Research Projects at University of Maine

Following is a list of the research work being conducted at the Highway Testing Labatory of the University of Maine:

1. Abrasion Test for Portland Cement Mortars.
2. A Study of the Effect of Mica on the Strength of Mortars.
3. A Study of the Effect of Crusher Dust on the Strength of Sands.
4. A Study of the Accuracy of Check Tests upon Sand Mortars in Tension and in Compression.
5. A Correlation Study of the Effect of the Size of the Sand Particles upon Mortar Strength in Tension and in Compression.
6. A Study of a Two-inch Cube as a Substitute Specimen for Tension and Compression Tests of Cement and Sand Mortars.

Results of State Roads in North Carolina *

The building of our State system of highways in North Carolina during the last five years has linked together our great trunk-line railroads and our waterways into an effective transportation machine.

In this period of five years from 1921 to 1926, North Carolina has probably made greater progress agriculturally, industrially, and socially than any other State in the Union in a similar period of time.

One of the most important factors in this metamorphosis has been our highway improvement program, involving the building of $125,000,000 worth of highways since 1919—most of it since

*High points of a statement made by Frank Page, chairman of the North Carolina State Highway Commission, in a hearing before the Interstate Commerce Commission.

1921 when we issued $50,000,000 in bonds and later $35,000,000 more to build a State system of highways.

We have increased the number of our farms by 13,000 during a period when the number of farms for the country as a whole fell off.

We have built consolidated rural schools valued at $35,000,000. To these each school day are brought 100,000 pupils in 2,000 school busses operating 40,000 miles—largely on the State system.

We have developed 40 cooperative farm marketing associations, many of them stimulated by our State Department of Agriculture, and engaged in shipping carload after carload of poultry, eggs, hogs, fruits, and vegetables that we formerly never grew for outside sale.

Roadside markets and city curb markets have stimulated the growing of truck produce on our farms and are the outlet for the farm surplus. The farm women are the merchandisers of this surplus and with the first available cash money most of them have ever had are putting modern conveniences into their homes, dressing themselves and their children better, painting their houses, and beautifying their yards.

We have recovered our lost provinces—those sections of the State to the far east and west formerly foreign to the State so far as transportation connections of any kind were concerned. To reach some of these points in our own State involved rail travel through one and sometimes two adjoining States. Our highways were out of the question for travel to these places. To-day the roads have gone through and we have put every part of the State within reach of every other part—almost from sunrise to sunset over the State highway system.

The State of North Carolina has taken the lead in spindle hours operated by cotton mills.

The true value of our property has multiplied eight times since 1900 while the entire country was increasing the true value of property by four times.

Our highway system makes our industry and agriculture inter-dependent—each supplying the other.

We have built our State system and are maintaining it entirely at the expense of the road user.

There is no State property tax for highways. State highway moneys come from three sources—bonds, motor registration fees, and gas taxes. The bonds are issued serially and are retired through a sinking fund maintained entirely by the motor taxes.

The "Berkeley Mix" for Patching Asphalt Pavements

By C. H. Thomas *

The Berkeley street department has developed a hot asphaltic mixture for patching asphaltic pavements that has been tested during eighteen months of application and found to be far superior to anything tried before. This is a combination of aggregate about midway between sheet asphalt and Topeka mix. We call it the "Berkeley Mix", and this method of repairing streets the "Berkeley Method".

The old method of smoothing bumps and chuck holes from asphalt pavements by means of surface heating was a practise which could not be continued because each time the pavement was treated, approximately a quarter of an inch of the surface was burned and removed. The "Berkeley Method" is based on a different principle. It adds new material to the old, and builds up the pavement instead of tearing it down.

The method has been in use about eighteen months, and extensive repairs have been made on six streets and no failures have been reported. The patches have "stood up" in good shape, and maintenance has been low in cost.

Repairs by the "Berkeley Method" cost four cents a square foot, approximately the same as by the old surface heating method. Results, however, are much better, and the life of the pavement will be increased perhaps by several years.

The "Berkeley Mix" was made as hard as possible to overcome the effect of the softer underlying material.

The following table shows the formula for the "Berkeley Mix", and its costs:

Material	Cost F. O. B. Car at Yard	Cost to Unload	Cost at Yard	Pounds per Cu. Yd.	Cost One Pound	Lbs. per Batch	Cost per Batch
Niles top gravel	$1.50 per ton	$.50	$2.00 per ton		$.001	60	$.0600
Birds-eye screenings	1.45 per yd.	.35	1.80 per yd.	2,600	.00069	60	.0415
Quarry Dust	at quarry .50 per yd.	haul .35	.85 per yd.	2,400	.00035	260	.0910
Antioch Sand	at quarry 1.15 per ton	haul .50	1.65 per ton		.000825	300	.2475
Monterey Sand No. 2	1.65 per ton	.50	2.15 per ton		.001075	120	.1290
Monterey Sand No. 4	1.65 per ton	.50	2.15 per ton		.001075	120	.1290
"E" Grade Asphalt	12.60 per ton	.25	12.85 per ton		.006425	110	.7068
Total one batch						1030	$1.4048

Percentage asphalt—10.6%

Cost of materials in one ton of mix shown above	$2.726
Fuel oil to mix one ton	.260
Plant engineer labor to mix one ton	.460
Plant labor to mix one ton	2.100
Total cost one ton	$5.546

*Assistant Superintendent of Streets, Berkeley, California.

The designations in the above table for types of sand are purely local terms, indicating the region of its source.

This patch has been applied to macadam streets and to two types of hard surface pavements in Berkeley. One type of hard surface pavement, used in the downtown section, has a six-inch cement concrete base with a two-inch asphaltic concrete top. For main arteries in the residential districts, a plain cement concrete pavement is used, a 1-2-4 mix, with either a six or seven inch thickness, depending on the character of the subgrade and the amount of traffic.

The method of applying the "Berkeley Mix" is simple, and requires a crew of from four to six men for efficient work. The mix is prepared at the city's corporation yard and hauled to the desired location in gravel trucks, steaming hot. A few drippings of tar over the surface depression, and the mix is shoveled on and spread out over the prescribed area. Accompanying illustration shows this. Hand rollers are used to smooth it out, and the patch is further compacted with tamps.

These patches take a fine feather edge, and they are finished off with a slightly roughened surface so as to prevent automobiles from skidding. The mix is ready for traffic in from two to three hours.

The method is the same for macadam street patching. Many of Berkeley's macadam streets were built a number of years ago and designed for horse-drawn vehicles. Later they were surface oiled with road oil to make them suitable for automobiles. But the continually growing truck and automobile traffic makes maintenance a hard problem, especially on these macadam streets.

The oil macadam pavement in Berkeley is constructed of crushed rock grading from 2½ inch diameter down to stone dust, which is compacted with a roller which weighs not less than four hundred pounds per lineal inch width of tread. Two oilings are used, the first one being one gallon per square yard of surface. The resulting pavement is six inches thick.

PREPARING "BERKELEY MIX" PATCH FOR ROLLER.

The use of birds-eye screenings was a development which we found profitable after first trying three-quarter inch screenings. But in August, 1925, we began using the ¼ inch birds-eye screenings, especially to spread over the asphalt sprayed on macadam street and trench repairs.

This makes a more satisfactory job than the coarse ¾ inch screenings formerly used. We ran a two weeks' test with the coarse screenings and a two weeks' test with the birds-eye screenings with the following results:

	Coarse	Birds-Eye
Cubic yards rock covered.....	110	158
Cubic yards of screenings used.....	102	76
Cubic yds of screenings to cover 1 cu. yd. of rock.....	.93	.48
Cost per yd. of screenings.....	$1.93	$1.95
Total cost of screenings used.....	137.70	148.20
Cost of screenings to cover 1 cu. yd. rock	1.25	.94

From this it appears that with the use of birds-eye screenings we are not only doing better work but that we are doing it cheaper, as the fine screenings cover a greater area.

The Berkeley street department has made a decided advance in the last year in several branches of its work. One notable improvement has been effected by requiring all public utility concerns to install, in advance of paving, new water services, gas services, etc., with new mains where necessary. Thus paving will not have to be torn up except for unforeseen contingences. Also lateral sewers are laid from the main sewer to the curb so that house connections for new buildings can be installed at any time.

A convenient method using charts has been devised for keeping track of all open trenches in the streets, so that the number of trenches open at one time will not be too great. Ordinances provide that work of backfilling and resurfacing these trenches must be done to the satisfaction of the Superintendent of Streets, and corporations are permitted to backfill and resurface their own trenches under city inspection if they so desire.

De-Ironing the Highways

Several states, counties and cities during the past year or two have adopted the use of lifting magnets for removing from the highways pieces of iron—usually nails or other sharp particles which might puncture automobile tires, which have been found to exist on them in previously unrealized quantities. In Kellogg, Idaho, in 1925 the Bunker Hill & Sullivan Mining & Concentrating Co. had considerable trouble with punctures and W. C. Clark, electrical engineer with the company, endeavored to remedy this by driving over the road a 5-ton truck from the rear of which was suspended a 36-inch magnet such as is used by the company for extracting tramp

iron from the ores; the magnet being so hung that its lower face was about 4 inches from the road surface. Electric current was furnished by 72 cells of regular locomotive-type storage batteries which were carried in the body of the truck.

The truck was first driven over a half mile of 18-foot concrete pavement, the magnet being carried just over the edge of the pavement, and 15 pounds of nails and tacks were picked up. Five miles of unpaved road was next covered, the road being surfaced with crushed gravel or rock which had been taken out of one of the mines, and from this the magnet picked up about 150 pounds of nails and many pieces of wire and small cotter pins which had rusted until both ends were very sharp.

The Idaho State Highway Department, learning of this, asked the company to "sweep" the road between Wallace and Mullen, 7 miles long. In seven trips over this road 603 pounds of nails and scrap were picked up, much of it so discolored by rust that it would not have been noticed by the eye.

Learning of the success of magnetic sweeping in Idaho, the Nevada State Highway Department has been using two smaller magnets suspended from the middle of a 5-ton truck, the magnets being so suspended that they can be raised or lowered to suit the character of the road. Magnetizing current is supplied by a 5 kw. direct current generator driven by a gasoline engine, the engine and generator being mounted as a unit in the truck. (This source of power is more economical than storage batteries and is recommended for outfits of this kind.) This road had been built over an old railway grade in which there were many track spikes. In one round trip on this 100-mile section 1,370 pounds of nails, spikes and scrap iron were picked up.

One of these outfits was then used on the streets of Carson City and 4,850 pounds of nails and similar metals were picked up in two days. A truck carrying two magnets suspended side by side a few inches above the road bed was used last summer in Nashville, Tenn.

Withdrawing a Bid*

The question of when and how a contractor may withdraw a proposal again came in for discussion at the Highway Department letting last Friday, when a bidder undertook to prevent consideration of an unopened bid which he had filed. This bidder had made proposals on two projects. After the first project was read he appeared to be low bidder and thereupon asked for the return of his proposal on the project yet to be opened, on the ground that he did not desire to secure both contracts.

The first impression of Mr. Watkins, upon receipt of this request, was to acquiesce in it as a matter of course and we wish to commend that attitude. When several projects are offered at the same hour, by the law of averages a bidder is almost forced to bid on several projects to be low on one. Should he be low on several and be required to accept all, he might be seriously embarrassed, whereas if permitted to withdraw his remaining bids after winning one job that situation, bad for both parties, could be avoided. The Department certainly is not seeking to compel any contractor to overload himself and that would be the result unless withdrawal were possible.

In this case the final decision hung upon the wording of the standard proposal requirements of the Department, paragraph 10, page 10, as follows:

WITHDRAWAL OF PROPOSAL. Bidders who have mailed or otherwise delivered their proposals to the State Highway Engineer before the time of the letting may withdraw them, on written request, at any time prior to the hour set for formally opening bids.

On the basis that this request was not made in writing prior to two o'clock, it was denied and the bid in question read. That it was not low is beside the question, since the point involved pertained to the privilege of withdrawing before reading. We contend that the bidder had the legal privilege of receiving his bid back, unread. The Department's notice to bidders cannot circumvent the law.

In many previous articles *The Scraper* has quoted law to illustrate that a bidder has a legal right to withdraw at any time before his proposal is accepted, entirely aside from any practical consideration such as the instant case. These decisions are so emphatic that some of them will bear repetition here.

In Younglove vs. Hoberg, 191 N. W. 985, the Iowa Supreme Court said, "His (the bidder's) contention is that the offer contained in his bid was not accepted until after the same had been withdrawn and that, therefore, no contract was performed between the parties. The law in cases of this kind is well established, and quite elementary. An offer may be withdrawn at any time before it is accepted, and the acceptance communicated, when communication is necessary."

The same conclusion is found in Goodpaster vs. Porter, 11 Iowa 163. "A mere offer, not assented to, constituted no contract, for there must be not only a proposal but an acceptance thereof. So long as a proposal is not acceded to, it is binding upon neither party and may be retracted. Until both parties are agreed, either may withdraw an offer which he has made. It has been held that such a right does not constitute a contract until accepted or acted upon, and that prior thereto it may be withdrawn."

In spite of the extensive discussion which this subject has had in recent years, there are still some who evince surprise when told the purport of the law and who ask what is the object of a certified check. The answer is found in the proposal form of the Highway Department:

"We enclose herewith certified check . . . as a guarantee of good faith, and which, *if the contract be awarded to us,* we agree to forfeit . . . in the event of our failure to enter into contract . . . within ten (10) days after receiving *official notice of award.*"

"It is further agreed that this proposal shall remain in force until the acceptance of this or some other proposal and the following formal executing and delivery of the

*From "The Scraper," publication of the Kentucky Association of Highway Contractors.

contract and the furnishing and acceptance of the contract bond.

Boiled down, this forfeits the check if the bidder refuses to sign a contract within 10 days *after award* but if he has withdrawn previously there is nothing to award. In the language of the Younglove case, "No contract was performed between the parties." This appears correct, even against the last sentence above quoted from the proposal form, for the *entire* "offer may be withdrawn" regardless of its wording, provided the bidder exercises his right before the bid is formally accepted by the Highway Commission.

Snow Drift Prevention

Objects of prevention, location of obstructions, and kinds of obstructions used. Winter studies for planning prevention methods

In our December issue a brief summary was published of information on snow removal and prevention which had been furnished by the Bureau of Public Roads. The subject of prevention has not, it seems to us, been given the general consideration which it deserves, and it seems worth while to present somewhat more fully the Bureau's discussion of this subject, which we are doing in the following paragraphs.

Prevention methods do not prevent the falling of snow upon the road, but the drifting of snow, especially in cuts; and prevention of these drifts renders much easier the work of the snow plows and also prevents the drifting in of the road after the plow has passed; the latter, perhaps, being the greater benefit of the two.

Prevention of drifting is effected by providing wind obstructions a short distance to the windward of the road. It is found that in any one district most snow storms are accompanied by wind blowing from a given direction—generally from the northeast in the eastern part of the United States. The structures used for decreasing the velocity of the wind are termed snow fences, although in some cases they consist only of brush. These fences are, of course, serviceable only where drifting occurs, and in some sections of the country there is no use for or value in them.

Speaking generally, the colder the winter climate the greater the amount of drifting, since in the warmer climates the snow is apt to soften on top and either freeze into a crust or remain too heavy to be blown about. New Jersey with an average yearly snow fall of 31.8 inches and an average winter temperature of 31.3 degrees reports that but fifteen miles of road on its snow removal program is subject to drifting and but little snow fence is required over the entire system. In Minnesota, however, with an average snow fall of 38.7 inches and an average winter temperature of 12.4 degress, over 800,000 linear feet of the lighter type of snow fence has been procured and 8,000,000 linear feet of snow fence is contemplated for the drift prevention program. Considerable snow fence is also used in the upper peninsula of Michigan. Marquette County employs three miles of the railroad type, 2,000 feet being installed in one continuous section. Figures for last winter were furnished showing the use of about 1,080 miles of the picket wire-woven type of snow fence in the United States, 195 miles of the so-called railroad or heavier type, and 50 miles of miscellaneous design.

Among the miscellaneous fences employed, rows of evergreen boughs have in some instances been set and in Houghton County, Michigan, snow blocks have been cut and piled into a fence for the same purpose, it being found that one man can cut blocks and build one quarter of a mile of this fence a day at a cost of between three and five cents per running foot.

Through shrub or brush country, or forests with either small or large standing trees, snow drifting does not occur, as the standing trees and brush appear to break the wind sweep before it reaches the road bed. Over the upper peninsula of Michigan the state is acquiring rights of way 400 feet wide to wooded land, and the trees and brush will be left standing when the highways are improved and act as drift preventives and also to add scenic beauty to the highways.

The location of the fence is even more important than the character of it, and a study should be made during the winter season to determine just which sections of the road are subject to drifts, the prevailing wind when drifting occurs, the existence of natural or topographical features which affect the direction and intensity of air currents, and whether there are any weeds or other vegetation, or fences or other removable structures which cause drifting in the roadway. Drift prevention surveys have been reported by a number of county and state organizations during the past winter. Officials of the state of Michigan and also of Onondaga County, New York, have made special efforts toward surveys of this nature. The local engineers of Michigan contemplate visual and hand level surveys of drifting sites and from the resultant diagrams and field study, determine the most effective position for the snow fence for that and other sites of similar cross sections.

Artificial obstructions should be removed if they tend to produce drifting in the road, among them being weeds and vegetation near the edge of the roadway, tight board fences, etc. The weeds should be cut and the board fences either moved back or replaced with wire fence.

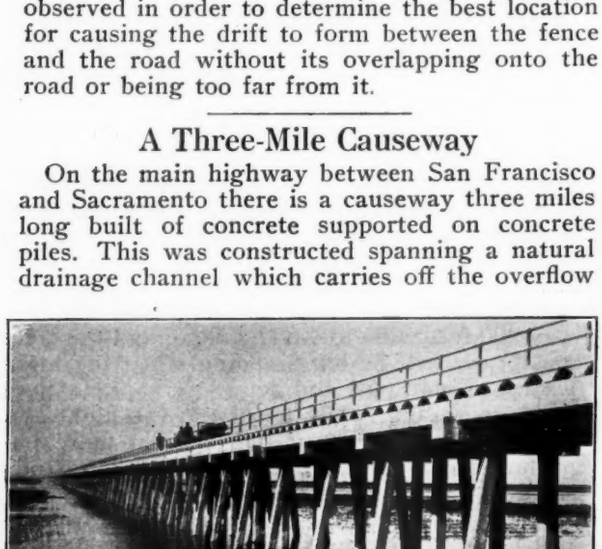
A number of state and county highway organizations, in designing new improvements, are avoiding shallow cuts to a large extent and elevating the grade over level stretches where possible, with a view to preventing snow drifting.

Studies of the locations needing snow drift prevention and of the best methods of providing such prevention can not be made beforehand, but must be made during and after storms, and

therefore it is advisable that all state and county highway departments provide for the carrying on of such a study during the coming winter. Ordinarily local maintenance forces, or the more intelligent men in charge of them, are best fitted for making this study and they should be given instructions to obtain the necessary data during and after storms and report the same to the central office after each storm. Temporary snow fences may well be placed where the preliminary data indicates their necessity and the effect studied; the position of the fence possibly being changed once or twice after the effect has been observed in order to determine the best location for causing the drift to form between the fence and the road without its overlapping onto the road or being too far from it.

A Three-Mile Causeway

On the main highway between San Francisco and Sacramento there is a causeway three miles long built of concrete supported on concrete piles. This was constructed spanning a natural drainage channel which carries off the overflow



THREE-MILE CAUSEWAY NEAR SAN FRANCISCO

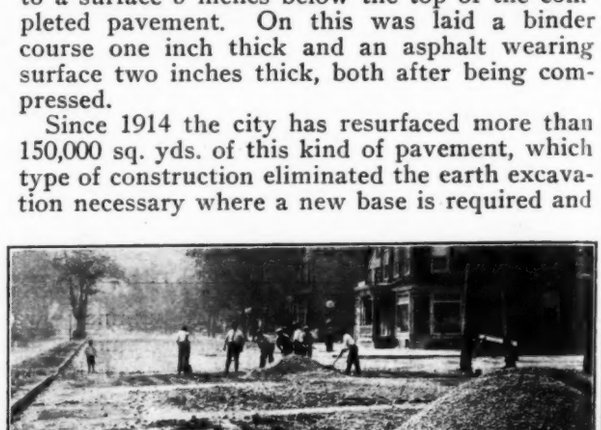
water from the Sacramento river in time of floods and prevents flooding of the upper part of the valley. The illustration shows the causeway during one of these floods.

Resurfacing Elizabeth's Telford Pavements

In a paper before the American Society for Municipal Improvements Thomas E. Collins, city engineer of Elizabeth, New Jersey, described the methods employed in that city for salvaging old Telford pavements which were no longer adequate to carry present-day traffic. These pavements had been built of three courses of trap rock with a total thickness of 14 inches. They had given good service with horse-drawn traffic, but automobile traffic had made it necessary to spend so much on repairs that it was economically necessary to either replace or resurface them. As they furnished an excellent foundation, the latter was decided upon.

Resurfacing was conducted as follows: Blue stone curb was removed and re-set in concrete to the new established grade, new curb stones being supplied where necessary. Stone block gutters, which had been laid in connection with the old Telford road on each side of the roadway, were removed and replaced with concrete. The surface of the old Telford pavement was then thoroughly swept by a machine sweeper and cleaned by stiff rattan brooms, scarified, loosened and re-shaped, new two-inch trap rock stone being added where necessary to bring the surface to the proper shape and crown. The surface was then covered with screenings and thoroughly rolled to a surface 3 inches below the top of the completed pavement. On this was laid a binder course one inch thick and an asphalt wearing surface two inches thick, both after being compressed.

Since 1914 the city has resurfaced more than 150,000 sq. yds. of this kind of pavement, which type of construction eliminated the earth excavation necessary where a new base is required and



SPREADING STONE ON OLD TELFORD PAVEMENT

OLD TELFORD PREPARED TO SERVE AS BASE FOR ASPHALT

LAYING ASPHALT BINDER ON OLD TELFORD

COMPLETED ASPHALT PAVEMENT ON OLD TELFORD PAVEMENT AS BASE

effected the savings of the cost of constructing a new 6-inch concrete base The average difference in cost per square yard between a new asphalt pavement with a 6-inch concrete base and a new asphalt pavement using the old Telford pavement as a base, is about $1.40 a square yard. Six streets in the city have Telford pavements which are over ten years old which have been used as bases for asphalt pavement. They have been subjected to heavy traffic, and a recent inspection shows that the Telford bases are standing up excellently.

Unusual Concrete Paving Construction Record*

Stop-watch records on Missouri concrete paving contract show efficiency above 90 per cent.

Reported by C. F. Rogers, United States Bureau of Public Roads

During the 1925 construction season the Ross Construction Co., of Kansas City, Mo., Henry Kleifeld superintendent, completed a concrete paving job in Lafayette County, Mo., on which the standard of efficiency was so high that the results obtained deserve the acknowledgment of the widest possible publicity. One 5-bag mixer was used on this work. The batch was a standard 5-bag batch of the standard proportion of 1:2:3½. The pavement section was the standard Missouri Maricopa section with the dimensions of 9 by 6 by 9 inches.

During the full construction season a little over 24 miles of pavement were laid, not quite all of it on this project. At no time was more than one mixer used, although the company had an extra mixer available which was used as stand-by equipment. The records obtained by the Bureau of Public Roads do not cover the full year's work, which was continued for something more than a month beyond the period for which the record was kept. However, the balance of the record would add little or nothing in the way of information to what is here given.

Table 1 shows the number of hours of work each day, the number of lineal feet of pavement laid, and the reasons for such delays as were encountered. The table also shows the total number of days of work, the total number of feet laid, and the average number of feet laid per hour for each month and for the whole period. The record of 94.94 feet laid per hour for 994 hours of operation with 42.2 batches per hour for every hour worked is the highest production that bureau representatives have ever found.

Table 2 is a stop-watch analysis of a perfect hour's operation—the only one ever encountered in a good many hundred hours of stop-watch readings on mixer operation. Table 3 gives the stop-watch readings on an ordinary hour's production; and Table 4 gives the summary of seven successive studies made on this job and indicates the efficiency maintained during ordinary operation.

This record is published because it is a practical demonstration of the fact that very high efficiency can be maintained on paving work if the job is properly organized and energetically administered. It may be of interest to add that while the stop-watch studies reported in Tables 2 and 3 were taken by representatives of the Bureau of Public Roads, the use of the stop watch was not new to the superintendent of this job and the studies revealed nothing that he had not learned before the bureau's representatives arrived. The job was not only well organized but its organization was based on a thoroughgoing conception of the principles of scientific management, which have been discussed in previous articles on concrete construction work published in *Public Roads*.

Table 1.—Daily record of concrete road construction on Missouri Federal-aid project 228

*Section	Date (1925)	Hours of work	Length of pavement laid Feet	Average length of pavement laid per hour Feet	Weather and remarks
F	Apr. 22	5	381	.....	Fair and warm.
	23	10	877	.....	Cool and Cloudy.
	24-25	Idle.	.....	.....	Rain.
	26	10	883	.....	Fair and cool.
	27-28	Idle.	.....	.....	Rain.
	29	4	315	.....	Stop, 40-mile wind.
	30	10	909	.....	Fair and cool.
T'l for month		39	3,365	86.3	
	May 1	10	1,006	.....	Fair and warm.
	2	10	1,005	.....	Do.
	3	10	978	.....	Do.
	4	10	1,003	.....	Cool and cloudy.
	5	10½	1,034	.....	Fair and cool.
	6	10	965	.....	Cool and cloudy.
	7	5	491	.....	Rain in morning.
	8	5½	494	.....	Rain in afternoon.
	9-10	Idle.	.....	.....	Rain.
	11	10	991	.....	Fair and cool.
	12	.....	.....	.....	Move to section E.
E	13-14	Idle.	.....	.....	Rain.
	15	5	392	.....	Rain in afternoon.
	16-17	Idle.	.....	.....	Rain.
	18	5	434	.....	Wet subgrade, m'ning.
	19	10	997	.....	Fair and cool.
	20	11	1,104	.....	Fair and warm.
	21	10½	1,027	.....	Do.
	22	10	1,000	.....	Do.
E & F	23	11	1,102	.....	Cool and cloudy.
F	24	Idle.	.....	.....	Stockpile low.
	25	10½	1,072	.....	Fair and cool.
	26	10	1,015	.....	Fair and warm.
	27	10	968	.....	Cool and cloudy.
	28	8½	835	.....	Cloudy, 4:30 rain.
	29	1	46	.....	Connecting slab.
	30 and 31	.....	.....	.....	Move to section D.
T'l for month		183½	17,959	97.8	
D	June 1	1	56	.....	Cloudy, warm, rain.
	2-3	Idle.	.....	.....	Wet subgrade.
	4	5	345	.....	Fair and warm.
	5	10	840	.....	Do.
	6	10	884	.....	Fair and hot.
	7	10	894	.....	Do.
	8	10	914	.....	Do.
	9	10	883	.....	Bridge approach.
	10	10	606	.....	Do.
	11	10½	1,066	.....	Fair and warm.
	12	5½	542	.....	Rain in afternoon.

*From "Public Roads," the official publication of the U. S. Bureau of Public Roads.

Table 1.—Daily record of concrete road construction on Missouri Federal-aid project 228—Continued

Section	Date (1925)	Hours of work	Length of pavement laid	Average length of pavement laid per hour	Weather and remarks
			Feet	Feet	
D	June 13	Idle.	.....		Wet subgrade.
	14	10	989	.....	Fair and warm.
	15	10	952	.....	Fair and hot.
	16-19	Idle.	.....		Rain & wet subgrade.
	20	10	964	.....	Fair and hot.
	21	10½	1,038	.....	Do.
	22	4	360	.....	Rain in afternoon.
	23	Idle.	.....		Wet subgrade.
	24	7	654	.....	Rain.
	25	10	1,024	.....	Fair and cool.
	26	10½	1,040	.....	Fair and warm.
	27	10	1,031	.....	Do.
	28	8½	834	.....	Do.
	29	Idle.	.....		Rain.
	30	10½	1,027	.....	Fair and warm.
T'l for month		183	17,033	93.0	
	July 1	10	887	.....	Fair and hot.
	2	10	953	.....	Do.
	3	10½	1,003	.....	Do.
	4-5	Idle.	.....		Rain & wet subgrade.
	6	10½	1,045	.....	Fair and warm.
D and E	7	10½	1,060	.....	Fair and hot.
	8	10	1,012	.....	Do.
	9	9	863	.....	Do.
	10	10	955	.....	Do.
	11	10	782	.....	Bridge approach.
	12	9	846	.....	Rain, 5 p. m.
	13	2	155	.....	Rain, 9:30 a. m.
	14	Idle.	.....		Wet subgrade.
	15	10	856	.....	Heavy subgrade.
	16	10	913	.....	Fair and warm.
	17	10	900	.....	Do.
	18	10	979	.....	Do.
	19	Idle.	.....		Low water supply.
	20	1½	94	.....	Rain, 10 a. m.
	21	5	469	.....	Wet subgrade, m'ning.
	22	10½	1,060	.....	Fair and warm.
	23	10	1,015	.....	Do.
	24	10½	1,050	.....	Do.
	25	9	798	.....	Cloudy and cool.
	26	Idle.	.....		Rain.
	27	10	932	.....	Fair and warm.
	28	10½	1,048	.....	Do.
E and F	29	4	335	.....	Move to section F.
F	30	9	906	.....	Rain.
	31	7	635	.....	Wet subgrade, m'ning.
T'l for month		228½	21,551	95.9	
	Aug. 1	10	972	.....	Fair and warm.
	2	10	990	.....	Do.
	3	5	503	.....	Cement low.
	4	10½	1,057	.....	Fair and warm.
	5	10½	1,088	.....	Do.
	6	10	1,000	.....	Do.
	7	5½	499	.....	Rain in morning.
	8	11¼	1,151	.....	Fair and warm.
	9	6½	614	.....	Move to section B.
	10-13	.....	.....	.....	Do.
B	14	7	400	.....	Fair and warm.
	15	11¾	1,129	.....	Do.
	16	10½	907	.....	Do.
	17	Idle.	.....		Rain.
	18	10½	980	.....	Fair and warm.
	19	10½	989	.....	Do.
	20-21	Idle.	.....		Rain & wet subgrade.
B and C	22	10½	990	.....	Fair and warm.
C	23	10½	985	.....	Do.
	24	10½	1,071	.....	Do.
	25	10½	1,056	.....	Do.
	26	10½	1,023	.....	Do.
	27	11½	1,089	.....	Do.
	28	10¾	1,068	.....	Do.
	29	10½	1,060	.....	Do.
	30	9½	906	.....	Move loader.
	31	10½	1,006	.....	Fair and warm.
T'l for month		234¾	22,533		
	Sept. 1	10½	1,002	.....	Do.
	2	10½	998	.....	Do.
	3	10½	988	.....	Do.
	4	10	934	.....	Do.
	5	10½	1,064	.....	Do.
	6-7	Idle.	.....		Rain & wet subgrade.
	8	9	863	.....	Fair and warm.
	9	10¾	1,073	.....	Do.
C	Sept. 10	7	651	.....	Cloudy, rain.
	11-13	Idle.	.....		Rain.
	14	5	443	.....	Rain, afternoon.
	15	10½	1,038	.....	Fair and warm.
	16	11½	1,110	.....	Do.
	17	10	978	.....	Do.
C and D	18	10	834	.....	Do.
T'l for month		125¾	11,976	95.2	
Total		994½	94,417	.....	

Average 94.94 feet per hour for 994½ hours.

Table 2.—Stop-watch study of a perfect hour's operation on concrete pavement construction, Missouri Federal-aid project 228*

Batch No.	Mixing time: Charge Minutes	Mix Minutes	Discharge Minutes	Batch No.	Mixing Time: Charge Minutes	Mix Minutes	Discharge Minutes
1.....	0.16	1.04	0.06	27.....	0.16	1.03	0.06
2.....	.16	1.04	.06	28.....	.16	1.02	.04
3.....	.16	1.05	.06	29.....	.16	1.04	.04
4.....	.16	1.02	.04	30.....	.16	1.04	.06
5.....	.16	1.04	.04	31.....	.16	1.04	.08
6.....	.16	1.04	.05	32.....	.16	1.06	.04
7.....	.16	1.05	.03	33.....	.16	1.03	.06
8.....	.16	1.02	.05	34.....	.16	1.02	.06
9.....	.16	1.03	.06	35.....	.16	1.04	.05
10.....	.16	1.04	.03	36.....	.16	1.03	.04
11.....	.16	1.04	.06	37.....	.16	1.06	.05
12.....	.16	1.03	.04	38.....	.16	1.05	.07
13.....	.16	1.04	.06	39.....	.16	1.03	.05
14.....	.16	1.02	.04	40.....	.16	1.03	.05
15.....	.16	1.04	.06	41.....	.16	1.03	.06
16.....	.16	1.02	.09	42.....	.16	1.06	.06
17.....	.16	1.04	.05	43.....	.16	1.04	.08
18.....	.16	1.02	.05	44.....	.16	1.04	.04
19.....	.16	1.04	.05	45.....	.16	1.03	.04
20.....	.16	1.04	.04	46.....	.16	1.04	.07
21.....	.16	1.04	.05	47.....	.16	1.05	.05
22.....	.16	1.04	.04	48.....	.16	1.06	.09
23.....	.16	1.01	.04				
24.....	.16	1.05	.05	Total..	7.68	49.79	2.53
25.....	.16	1.03	.04	Average...	.16	1.04	.05
26.....	.16	1.05	.05	Percentage	13	83	4

*During this hour's operation 48 batches were produced—the maximum possible number under the specifications. There was no lost time.

Table 3.—Stop-watch study of an ordinary hour's operation

Batch No.	Mixing time: Charge Minutes	Mix Minutes	Discharge Minutes	Lost time: Mixer trouble Minutes	Truck shortage Minutes	Water-supply trouble Minutes
1.....	0.16	1.03	0.10	....	....	....
2.....	.16	1.07	.08	....	....	....
3.....	.16	1.02	.06	....	....	....
4.....	.16	1.05	.07	....	....	....
5.....	.16	1.03	.08	....	....	....
6.....	.16	1.01	.10	.08	....	....
7.....	.16	1.02	.06	....	....	....
8.....	.16	1.05	.10	....	.02	....
9.....	.16	1.03	.07	....	....	....
10.....	.16	.96	.06	....	....	....
11.....	.16	1.01	.06	....	....	....
12.....	.16	1.02	.06	....	....	....
13.....	.16	1.02	.07	....	....	....
14.....	.16	1.00	.03	....	....	....
15.....	.16	1.04	.05	....	....	....
16.....	.16	1.03	.06	....	....	....
17.....	.16	1.01	.04	....	....	....
18.....	.16	.96	.05	....	....	....
19.....	.16	1.03	.07	....	....	....
20.....	.16	1.04	.07	....	....	....
21.....	.16	1.01	.06	....	....	....
22.....	.16	1.01	.05	....	....	....
23.....	.16	1.04	.10	....	1.86	....
24.....	.16	1.05	.06	....	....	....
25.....	.16	1.01	.06	....	....	....
26.....	.16	.97	.05	....	....	....
27.....	.16	1.01	.07	....	....	....
28.....	.16	1.00	.07	....	....	....
29.....	.16	1.03	.07	....	....	....
30.....	.16	.96	.08	....	....	....
31.....	.16	1.05	.10	....	.10	....
32.....	.16	.106	.04	....	....	....
33.....	.16	1.00	.05	....	....	....
34.....	.16	1.01	.08	....	....	....
35.....	.16	1.03	.10	....	.04	....
36.....	.16	1.02	.10	....	.06	....
37.....	.16	1.05	.10	....	....	1.24
38.....	.16	1.06	.10	....	....	....
39.....	.16	1.06	.08	....	....	....
40.....	.16	1.07	.07	....	....	....
41.....	.16	1.04	.07	....	....	....
42.....	.16	1.06	.10	.10	....	....
43.....	.16	1.04	.09	....	....	....
44.....	.16	1.02	.06	....	....	....
45.....	.16	1.02	.10	....	....	....
Total.....	7.20	46.11	3.19	.18	2.08	1.24
Average....	.16	1.02	.07	....	....	....
Percentage..	12	77	5½	....	3½	2

Table 4.—Summary of seven stop-watch studies

Study No.	No. of batches per hour	Efficiency of outfit column 2 divided by 48 Per ct.	Mixer time: Charge Secs.	Mix Secs.	Discharge Secs.	Total Per ct.	Lost time: Truck delays Secs.	Water supply trouble Secs.
1.....	44	91.7	9.6	62.4	3.0	92	8	....
2.....	44	91.7	9.6	61.8	3.0	91	9	....
3.....	45	95.8	9.6	61.2	4.2	94½	3½	2
4.....	44	91.7	9.6	61.8	4.2	92	8	....
5.....	42	87.5	9.6	62.4	4.2	89½	10½	....
6.....	48	100.0	9.6	62.4	3.0	100	....	....
7.....	45	95.8	9.6	61.2	4.2	93¾	6¼	....

Device to Support Reinforcing Steel in Concrete Pavements

A device which appears superior to any method yet proposed for properly supporting reinforcing steel in the construction of cement concrete pavements has been perfected by two engineers of Division VII, California State Highways, it is reported by S. V. Cortelyou, division engineer, in a letter to the Construction Department. It consists of a bar into which are fitted adjustable hooks that hold the reinforcement in correct position during placing of concrete. The bar when in use rests across the header boards, as shown in the accompanying illustration and sketch.

To hold mesh or bar reinforcing in place so that it will have a proper position in the concrete slab has ever been a problem in the construction of pavements. Formerly reinforcing was held up by a small pile of concrete mix placed on the subgrade, but the steel had to be adjusted from time to time as placing of the mix progressed. With constant watchfulness this method gave fair results, but was far from satisfactory.

Another plan sometimes followed was to place small blocks of concrete or rocks on the subgrade to hold the reinforcing. This method was never satisfactory and has long been discontinued. Still another method was the use of a sled dragged on the subgrade behind the mixer. The sled often gave better results than other methods but had many objectionable features.

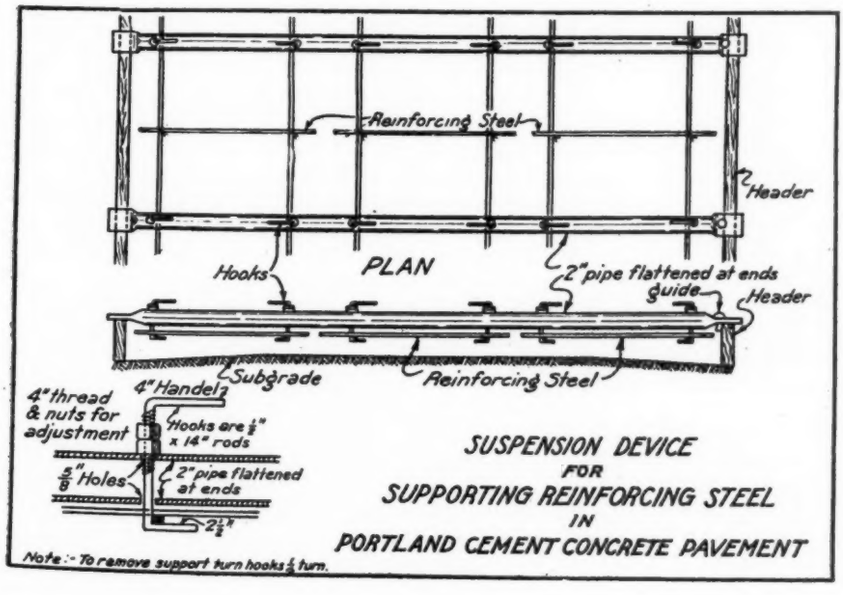
A more recent plan is the use of especially manufactured steel pins or chairs. (Such pins have been specified for use on the Debo cut-off project near Oxnard, where they will be tried for the first time in Division VII.) Pins or chairs, however, can not be used on second-story concrete since the pins can not be driven into the old base and chairs must be held against slipping.

The plan of the bar and hooks, as worked out by Resident Engineer W. D. Eaton and Assistant Resident Engineer Walter T. Lamb on the Jahn and Bressi contract in San Diego County (M-93 VII-S.D.-2-C&D), seems to have many advantages over any of the above methods. By it, the reinforcing steel may be placed in correct position and held there. Numerous tests of the position of the steel after tamping of the fresh concrete demonstrate this to be a fact.

The device is left in position until the concrete is spread and is removed just ahead of the tamper. The hooks are adjustable and can be changed for different thicknesses of pavement, while the drilling can be varied to suit any type of reinforcement.

The division believes the success of the device is assured. It is positive in the placing of the reinforcement, costs little, and is simple in operation.

(From "California Highways," bulletin of the State Highway Commission.)



Renewing a Broken Culvert

Renewing a 24-inch pipe culvert which had cracked in many places, without tearing up the roadway or interfering with traffic was successfully performed last year by Hunter & Bond, a highway contracting firm of Ohio.

This culvert had a cover of between 6 and 7 feet below the road bed, which was 21 feet wide between the inside of the headwalls, and the culvert itself was 24 feet long.

The procedure was as follows: Beginning at the outlet end, two 2-foot sections of the old pipe were broken out and removed, the opening slightly enlarged, and the end of an Armco corrugated culvert pipe pulled in four feet. The third section of pipe was then broken out and the new culvert immediately drawn ahead to take its place; and this process was repeated until the new pipe had been drawn entirely through. Jacking the pipe through might have been the most desirable method, but no backstop for the jacks was available at the lower end, the nearest bank being 15 feet away. The contractor therefore placed a cross beam across the lower end of the pipe and attached to it a pulling rope which was passed through the culvert to the upper end. A short distance above the upper end a 6x6 post was driven into the ground and braced against the upper headwall to serve as a deadman, and to this a one-ton Yale differential pulley chain and block with 8-inch sheaves and a ½-inch wire cable were used to draw the culvert.

The old pipe was removed by a man lying inside the new culvert pipe who broke the old pipe into fragments with a

small sledge hammer and then troweled away the sides and ceiling to provide ample clearance for the new pipe. The excavated dirt and broken pipe was placed in a wooden box and drawn out by a workman on the outside. One man was able to pull the culvert in for the first four feet, but as the friction increased with the length six men were needed for drawing in the final foot. These men were brought from other work to do the pulling from time to time whenever required.

The total cost of installing the new culvert was $40.60, of which $21.60 was the cost of removing the old pipe and pulling the new one through, this requiring 54 man-hours at 40c. an hour. The other items were: 9 hours foreman at 80c.; $3.00 for the automobile to take the men to the job; $1.60 for placing the deadman; $1.50 for hauling pipe; $1.00 for placing and connecting pipe; $1.00 for lumber for deadman; $1.00 for use of tools, and $2.70 for cement and sand and placing the same as mortar between the new pipe and the old masonry head walls. It was estimated that if placed by the open trench method, the cost would have been $58.35, of which about $34.50 would have been for excavation and backfilling and $1.50 for replacing the gravel road surface. In addition to the saving and of even more importance, was the avoidance of a cut in the road bed and of interfering with the traffic during the operation.

Surface Treatment of Dallas County Roads

By A. D. Stivers *

Dallas county, Texas has a larger population than any other in the state. Dallas, the county-seat, with a population of 250,000 is surrounded by agricultural communities and is a big cotton market, and the highways of the county therefore receive a heavy traffic.

In 1919 Dallas county started spending a $6,500,000 road bond issue, increased by federal and state aid. A system of roads was laid out which amply provides for the needs of the county and will for many years to come. The main highways were paved with asphaltic concrete, sheet asphalt, brick, etc.

After the main highways had been paved there were left many important roads carrying heavy traffic. Surfaces costing twenty and thirty thousand dollars per mile were out of the question for these roads, but traffic as high as five thousand vehicles per day on some of them made it necessary to provide a smooth, dustless, durable surface on an adequate base. After a thorough study of conditions the engineers, Nagle, Witt, Rollins of Dallas, selected for them asphaltic surface treatment on a macadam base. On some of the roads, a sub-base of local gravel or soft native limestone was first laid, and on this a water-bound macadam of hard limestone. The total thickness of sub-base and base was nine inches after being compacted by rolling and traffic.

The base was then thoroughly and carefully swept and given a surface treatment of Texaco No. 250 asphalt and Joplin chat screenings. The asphalt used is a very soft asphalt with a penetration of 250-300 and a melting point of 85°-115°F. This material was applied by pressure distributor at the rate of one-half gallon to the square yard at a temperature of from 300° to 350°F and immediately covered with screenings at the rate of 60 to 65 square yards to one cubic yard. Traffic was then immediately turned on to the road.

Great care was taken to have the surface swept perfectly clean and the contractors were not allowed to pour asphalt when the weather was cold or when the surface of the road was not perfectly dry. An even distribution of the asphalt was required. Any film of dirt or screenings which was present on the base was carefully removed and the surface of the base was swept until the surface stone were well exposed before the asphalt was poured. Any portions of the base which were loosened by this sweeping were hand patched with asphalt and stone before the surface treatment was applied.

The cover screenings were piled alongside the road in half-yard piles before the asphalt was applied and a large force of men was on hand so that the screenings could be spread over the asphalt before the latter had cooled. This is important in securing a good job. The surface secured was about six tenths of an inch in thickness.

The contractor was required to maintain the roads for a period of ninety days after their completion. This maintenance consisted merely in sweeping the cover material to the center of the road as it was displaced by traffic and in a few cases the addition of more cover material to correct "bleeding." It has been the writer's observation that the road which "bleeds" the most usually develops finally into the best road if the "bleeding" is properly taken care of.

A little more than one hundred miles of this type of road was constructed between the spring of 1921 and the end of 1923. The work was not confined entirely to secondary roads, but portions of important state highways were surfaced in this manner. Among the important roads a portion of which were thus surface-treated are State Highway No. 1 (The Bankhead Highway), the Dallas-Denton road, the Preston road, and the Dallas-Kaufman road. State Highway No. 1 probably carries the heaviest traffic in Texas.

Practically all of this road is in good condition today. There has, of course, been some maintenance, but this has been confined to the patching of small holes and small ravelled places along the edges of the roads. The total maintenance cost for the three to five years these roads have been in service has been low.

*Engineer, The Texas Company.

Recent Legal Decisions

CONSTRUCTION OF ROAD CONTRACT AS BETWEEN CONTRACTOR AND SUBCONTRACTOR

In a subcontractor's action against a road contractor for refusal to permit the subcontractor to complete the contract, which provided for the construction of the road to the satisfaction of the county engineer, and made his decision on the question final, the Texas Commission of Appeals holds, Craven v. Davison, 276 S. W. 193, that the engineer's determination in good faith that the subcontractor's work was unsatisfactory, and his demand that the contractor take over the work, required the contractor to complete the contract himself, the engineer's determination as to the necessity for taking over the work being conclusive, and the contractor's good or bad faith being immaterial; therefore the subcontractor could not recover for the loss of future net profits under the contract.

RECALL OF PETITION FOR ROAD DISTRICT HELD TOO LATE

The Kansas Supreme Court holds, True v. McCoy, 241 Pac. 249, that when a petition to organize a road benefit district has served its purpose, and the district is regularly organized, and substantial and orderly progress in the improvement of the road petitioned for has been accomplished pursuant thereto, it is too late for a recall petition authorized by Kansas Re. S. 68-601 to be effective in nullifying the original petition under which the district was organized and the work of road improvement begun.

MISSISSIPPI PUBLIC WORKS CONTRACTOR'S BOND DOES NOT COVER MONEY LOANED TO A SUB-CONTRACTOR TO PAY FOR MATERIAL OR LABOR

The Mississippi Supreme Court holds, Oliver Constr. Co. v. Crawford, 107 So. 877, that section 1, chapter. 217, Miss. Laws 1918, making a contractor's bond liable to all persons supplying labor or material for the construction work contracted for, does not make the contractor's bond liable for money loaned to a sub-contractor which is used in paying for material or labor. While the statute will receive a liberal interpretation, it will not be extended beyond the clear meaning of its terms.

REFORMATION OF CONTRACT TO DELIVER ROCK REFUSED WHERE MUTUAL MISTAKE NOT SHOWN

The Oregon Supreme Court holds, Hagman v. Webber, 243 Pac. 91, that where a contract for the delivery of rock for road construction work did not specify the total amount to be delivered, although the attention of both parties was directed to the matter when the contract was executed and no such provision was included, reformation of the contract to specify an amount to be furnished was held properly refused where the parties were in direct contradiction of each other on the matter and the omission was not due to mutual mistake; and without such reformation the road contractor could not recover damages for the increased cost over the contract price which he incurred in furnishing the balance of rock to complete his own contract.

GASOLINE AND OIL COVERED BY PUBLIC WORKS CONTRACTOR'S BOND WHERE STATUTE SPECIFICALLY INCLUDES FUEL

The Iowa Supreme Court holds, Standard Oil Co. v. Marvill, 206 N. W. 37, that supplying gasoline and oil to a contractor employed to spread gravel on a road is covered by a public works contractors' bond under Iowa Acts 38th Gen. Assem. c. 347, section 1, covering the furnishing of "any material, including fuel, in the carrying out of such public contract." It is held that the purpose of the statute which specifically includes fuel is to give a lien to persons who supply fuel material consumed in the prosecution of the work as well as to persons who supply materials directly used in such prosecution.

BUYER OF GRAVEL NOT CONFORMING TO SPECIFICATIONS HELD ENTITLED TO REFUSE DELIVERY AND RECOVER DAMAGES

Under the specifications for a concrete highway the gravel was required to be free from sand. A contract was made by the contractors for 1,000 cubic yards of gravel. After delivery of 170 cubic feet it was rejected by the inspector representing the highway commission as containing from 5 to 20 per cent. of sand. It was rescreened and again rejected as not complying with the specifications. Although good faith attempt had been made to comply with the contract, the Wisconsin Supreme Court held, Hageman vs. Ule, 206 N. W. 842, that the buyer was entitled to reject the gravel and recover damages for failure to deliver 830 feet of gravel, without giving the seller further time to regrade or make substituted delivery. The court said: "Contracts for goods of a specified quality to be delivered at a time certain do not contemplate deliveries by the trial and error method."

MISSOURI STATUTE AS TO OPENING OF ROADS BETWEEN TWO COUNTIES HELD MANDATORY

The Kansas City Court of Appeals, State v. McLanahan, 278 S. W. 88, holds that Mo. Rev. St. 1919, §10627, providing for the opening of roads between two counties, is not ambiguous, and when all its requirements have been complied with, and all relinquishments are in the hands of the engineers of the county courts, they must order the road opened, the statute being mandatory; and mandamus is the only appropriate remedy to compel them to perform this duty.

ENGINEER'S ACCEPTANCE OF ROAD CONSTRUCTION WORK BINDING AS BETWEEN CONTRACTOR AND SUBCONTRACTOR UNDER THEIR CONTRACT

The Texas Commission of Appeals holds, Deal v. Craven, 277 S. W. 1046, that the acceptance of road construction work by the county engi-

neer is conclusive as between the contractor and subcontractor on the question of performance where their contract made the work subject to the engineer's acceptance, his decision on all questions arising out of its performance to be binding on the parties.

ROAD CONTRACTOR'S DUTY TO GUARD EXCAVATIONS AT NIGHT

The Missouri Supreme Court holds, Melican v. Whitlow Const. Co., 278 S. W. 361, that, although a contractor constructing a culvert for a county is authorized to make the necessary excavations, where the character and location thereof make it a place of danger to persons using the road at dark, and who are not familiar with the existing conditions, it is the duty of the contractor to place and maintain, during the time of darkness, such lights or warning signals as would enable persons exercising ordinary care to discover the danger and pass in safety.

ROAD CONTRACTOR NOT RELIEVED FROM LIABILITY FOR UNGUARDED EXCAVATION BECAUSE COUNTY EMPLOYING HIM WOULD NOT HAVE BEEN LIABLE

In an action against a road contractor for injuries alleged to have been caused by defendant's negligence in failing to place a warning sign or guard rail at a ditch dug while building culverts on a public road, the Texas Court of Civil Appeals held, T. J. Mansfield Const. Co. v. Gorsline, 278 S. W. 485, that an independent contractor constructing a highway for a county is not relieved from liability for such a defect because the county would not have been liable, and the defendant's contract did not create the relation of master and servant between it and the county. Refusal to permit the contractor to prove that it constructed guards and a detour around the work and placed lights satisfactory to the county engineer, was held proper, since whether these were satisfactory to the engineer was not the test to determine negligence.

CONCLUSIVENESS OF DECREE FOR HIGHWAY ENGINEER'S CLAIM AGAINST IMPROVEMENT DISTRICT

The Arkansas Supreme Court holds, Tri-County Highway Improvement Dist. v. Vincennes Bridge Co., 278 S. W. 627, that a decree of the chancery court allowing a claim of the state highway engineer against a road improvement district was conclusive, in the absence of fraud or collusion in its procurement, where no appeal was taken, and the decree shows that it was heard on evidence, as it will be presumed on a collateral attack that any evidence necessary to support the decree was introduced.

STATE ROADS CONTRACTED FOR BY COUNTIES; MISSOURI STATUTE REQUIRES COMPETITIVE BIDDING AND PROVISION FOR PAYMENT OF COST MUST BE FOLLOWED

The Missouri Supreme Court holds, Hanick v. Marion County, 278 S. W. 730, that, under the express terms of Mo. Rev. St. 1919, § 10905, counties contracting for the construction of state roads as provided by § 10901 must let the contract by competitive bidding and a contract not so let imposes no obligation on the county.

Section 10901 provides that the county shall pay one-half of the cost of such construction. A contract which ignores this mandatory feature of the statute and provides, in substance, that the county shall finance the project and pay the contractor 60 per cent of the profits is unauthorized, illegal and unenforceable, the statute making no provision for division of profits.

BALANCE OF DEDICATED STREET NOT ABANDONED BY PAVING ONLY PART

The Indiana Appellate Court holds, Waters v. City of South Bend, 150 N. E. 67, that the grading to its full width of a 60 foot street in a residential district, which has been dedicated to the city, is sufficient evidence of the city's acceptance of the street to its full width, and the City does not abandon the balance of it by paving the street to a width of only 34 feet with an additional 5 foot sidewalk constructed by the abutting owners. The acquiescence of the city officials in the use by the abutting owners of the rest of the street to improve as their own did not defeat the city's right thereto, since a municipal corporation cannot sell or barter the public streets or surrender them to a licensee or bestow them as a gratuity.

BRIDGE OVER CREEK HELD NOT A LOCAL IMPROVEMENT JUSTIFYING SPECIAL ASSESSMENT

The Illinois Supreme Court holds, City of Chicago Heights v. Walls, 319 Ill. 411, 150 N. E. 241, that the construction of a concrete bridge over a creek was not a "local improvement" justifying a special assessment, although it might benefit adjoining property more than property at a distance, the primary purpose and effect being to benefit the public.

COMPENSATION FOR OPENING ROAD OVER LAND HELD UNDER GOVERNMENT PATENT

The Nebraska Supreme Court holds, Soulek v. Stiefvater, 206 N. W. 740, that land in Nebraska to which a patent has been issued under 25 U. S. St. at Large, c. 405, § 21, p. 896, falls within the general rule as to damages when a public road is opened across it, and before opening the road for public travel just compensation must be made or provided to be made to the owner for the damage done.

STATUTE AUTHORIZING AUDITORIUM DISTRICTS HELD UNCONSTITUTIONAL

The Arkansas Supreme Court, Lipscomb v. Lenon, 276 S. W. 367, defines a local improvement as a public improvement which, although it may incidentally benefit the public at large, is made primarily for the accommodation and convenience of the inhabitants of a particular locality, and which is of such a nature as to confer a special benefit upon the real property adjoining or near the locality of the improvement. It is held that a local improvement district cannot be created unless the land therein, whether entirely rural or urban or both, is peculiarly and especially benefited by the improvement, and that a statute authorizing the creation of community auditorium districts to build auditoriums for public meetings was unconstitutional as providing for assessment of country portions of townships without special benefit.

PERMIT FOR AND INSPECTION OF PRIVATE SEWER SYSTEMS BY BOARD OF HEALTH HELD PROPER

The California District Court of Appeal holds, Ex Parte Nichols, 241 Pac. 399, that, no provision being made by the charter of the city and county of San Francisco regulating the installation or alteration of sewerage systems in premises privately owned, or for the granting of permits therefor or inspection by the authorities of such work either during its progress or upon completion, and such regulation being within the powers granted to the supervisors, the requirement that a permit therefor be granted by the board of health, and that there be an inspection thereof by officers duly authorized, is not in conflict with the powers of the board of public works, or a delegation to the board of health of the power to legislate as to the terms and conditions upon which a permit should issue, but a proper preliminary requirement in order that it may be ascertained that the work or alteration proposed would be in acordance with the sanitary regulations of the board of supervisors, and may at the proper time be inspected to the end that the public health be preserved and protected.

DAMAGES FOR DESTRUCTION OF BUILDING TORN DOWN BY CITY AFTER CONDEMNATION PROCEEDINGS HELD NOT RECOVERABLE BY SUBSEQUENT PURCHASER

The Kansas Supreme Court holds, Sheaff v. Kansas City, 241 Pac. 439, that an owner of a building torn down by a city of the first class, acting in substantial compliance with an ordinance adopted under Kansas Rev. State section 13-136, cannot recover damages from the city for the destruction of the building, where he purchased it after condemnation proceedings had been commenced, and contracted with the seller to satisfy the health department of the city and to hold the seller harmless.

MAINTENANCE OF GARAGE FOR REPAIRING CITY AUTOMOBILES HELD A PROPRIETARY FUNCTION

The California District Court of Appeals holds, Bertiz v. City of Los Angeles, 241 Pac. 921, that a city is acting in a proprietary and not a governmental capacity in maintaining a garage for the repair of its automobiles, and is liable for the negligence of its agents in the course of employment in such enterprise. The city was held liable for the negligence of a mechanic at the garage who injured plaintiff while testing an automobile.

PREFERENCE TO RESIDENT BIDDERS AS TO AMOUNT OF BIDS HELD IMPROPER

The Washington Supreme Court holds, Reiner v. Clarke County, 241 Pac. 973, that county commissioners were without power to let a contract for highway surfacing involving more than $2,500 without complying with Rem. Comp. Stat. Section 6408, requiring a call for bids to be published for three consecutive weeks.

There is no statute of the state authorizing county commissioners to make or give any preference or adopt any policy giving preference to one bidder over another when required to receive competitive bids, by reason of nonresidence or anything else; and it was held that a policy to prefer bidders who were residents of the state to the extent of 5 per cent. of the amount of their bids was arbitrary and improper.

AGREEMENT WITH BIDDERS VOIDING PAVING CONTRACT

The Texas Court of Civil Appeals holds, Meyers v. Walker, 276 S. W. 305, that where an agreement was made with several bidders, after paving bids were opened, but before acceptance, that members of the city council make inspection trips to nearby cities, their expenses to be paid by the successful bidder, a paving contract made following thereon was against public policy and void, and an attempted ratification thereof could not make it valid.

INVALID PURCHASE OF MERCHANDISE BY CITY OFFICIALS

The Oaklahoma Supreme Court holds, Fabric Fire Hose Co. v. Haworth, 241 Pac. 477, that a contract by the board of trustees of an incorporated town for the purchase of merchandise when there are no funds in the treasury and no levy or estimate out of which the indebtedness created can be paid, and without the assent of three-fifths of the town's voters as provided by section 26, Art. 10, of the State Constitution, is void.

SUFFICIENCY OF SEWER PLANS AND SPECIFICATIONS FOR INFORMATION OF BIDDERS

The Missouri Supreme Court holds, Badger Lumber Co. v. Mullins, 275 S. W. 957, that a sewer construction was not void on the ground that the blueprints furnished bidders did not contain detailed plans for the type of sewer required, a reference to supplementary plans complying with an ordinance requiring detailed plans and specifications to be on file in the city engineer's office.

ORDINANCE RESTRICTING TRANSFER BUSINESS AT RAILWAY STATIONS HELD DISCRIMINATORY

Ordinances restrictive of the acts of persons soliciting passengers for hire upon railroad premises have often been upheld. They are said to rest upon the authority under the police power to enact reasonable regulations preventing annoyance to passengers and prospective passengers on the trains. But the Texas Court of Criminal Appeals, Ex Parte Maquard, 275 S. W. 1070, holds that a provision of an ordinance prohibiting those engaged in the transfer business from soliciting business on station grounds while passenger trains are delivering or receiving passengers, which exempts those under contract with the railroad company to transfer its through passengers and baggage to other stations in the town, was invalid as unjustly discriminatory.

CONSTRUCTION OF ORDINANCE PROHIBITING FILLING STATIONS NEAR CHURCHES, ETC.

A Chicago Ordinance prohibits gas and filling stations within 200 feet of property used for a church, school, theatre or hospital. The Illinois

Appellate Court holds, People v. McDonnell, 238 Ill. App. 224, that the ordinance applies to property on which there is a building only part of which is used for religious services, and that the Salvation Army is a religious organization and the building used by it is a church within the ordinance, although a few of its members were incorporated to handle the physical properties of the organization.

DISCRETION OF CITY OFFICIALS TO ISSUE RETAIL DEALERS' LICENSES

The Illinois Appellate Division holds, People v. Devon, 238 Ill. App. 255, that a writ of mandamus cannot be used to control or review the discretion of properly authorized city officials in the matter of issuing licenses (in this case to operate as a retail beverage dealer) unless there has been a clear abuse of that discretion. While such officials may not arbitrarily refuse to issue such a license, neither will they be compelled to issue one when in their discretion, reasonably and fairly exercised, it has been refused by them.

REPAIR OF STREETS OPENED BY CITY FOR SEWER PIPES HELD PAYABLE BY STREET RAILWAY UNDER ORDINANCE

The Illinois Appellate Court holds, Chicago City Ry. Co. v. City of Chicago, 238 Ill. App. 402, that under a city ordinance requiring a street railway company, at its own expense, to pave and keep in repair the portions of the streets occupied by it, the expense incurred by the company in repairing and restoring pavements removed by the city to install or repair sewer pipes for the benefit of owners of houses fronting on the streets occupied by the company's right of way, cannot be recovered in an action against the city. The company's obligation was more definitely set forth in an exhibit attached to the ordinance, providing that it should pave and repair the portion of the streets mentioned in the ordinance "whenever and as often as the same shall reasonably require paving, repaving or repairing." A city having the exclusive authority to grant or refuse permission to a railway company to lay tracks upon or across streets within the city limits, may, it is held, in granting such permission, impose such reasonable limitations and restrictions as it sees fit; such as, by ordinances, requiring the company to fill, grade, pave and otherwise improve the portion of the street occupied by its tracks and between them.

CONTRACT AND PROPERTY RIGHTS OF RAILROAD IN STREET SUBJECT TO REASONABLE REGULATION BY MUNICIPALITY

Contract and property rights of a railroad company in respect of the operation of a track in a public street are held subject to the fair exercise by a state, or by a municipality as its agent, of the power to make and enforce regulations reasonably necessary to secure public safety; such regulations being subject to judicial scrutiny as to their validity and reasonableness under organic law. Tampa Northern R. Co. v. City of Tampa, Florida Supreme Court, 107 So. 364.

OIL AND GASOLINE FOR MACHINERY USED IN DIGGING CANALS AND DITCHES WITHIN STATUTE AS TO CONTRACTOR'S BOND

The Mississippi Supreme Court holds, Standard Oil Co. v. National Surety Co., 107 So. 559, that oil and gasoline furnished a contractor for use in operating the machinery used by him in digging canals and ditches for a drainage district are "materials" used in the prosecution of the work within the meaning of section 1, chapter 217, Mississippi Laws of 1918, providing that contractors for public works shall give the usual bond, obliging the contractor to pay all persons supplying labor or material for the work.

ORDINANCE AND BIDDING REQUIRED FOR PUBLIC WORK ABOVE SPECIFIED AMOUNT

The Kentucky Court of Appeals holds, Board of Councilmen of Frankfort v. Noel, 281 S. W. 505, that a city of the third class did not acquire a lien on abutting property for the cost of oiling streets exceeding $500, where it did not authorize the expenditure by ordinance, advertise for bids, and let the contract to the lowest responsible bidder, as required by Ky. St. section 3440.

CITY'S RIGHT OF CONDEMNATION FOR FIRE STATIONS NOT AFFECTED BY RESTRICTIONS IN DEDICATION

The Texas Supreme Court holds, Wynne v. City of Houston, 281 S. W. 544, that restrictive covenants in the dedication of land to a city and in the deeds could not limit or affect the police power of the state acting through the city, to condemn the property for the construction of fire stations for the protection of the persons and properties of the inhabitants.

METHOD OF ASSESSING RAILROAD PROPERTY FOR HARD SURFACED ROAD

The Kansas Supreme Court holds, Atchinson, T. & S. F. Ry. Co. v. Board of Comrs. of Anderson County, 243 Pac. 282, that a board of county commissioners, in making an assessment against the property of a railroad company in a benefit district for the cost of constructing a hard-surfaced road, should follow the same general method as is followed with reference to other property which is liable for its proportionate part of such cost.

MUNICIPALITY POLLUTING STREAM BY SEWAGE HELD LIABLE TO LOWER REPARIAN OWNER FOR DESTRUCTION OF BUSINESS

The Oklahoma Supreme Court holds, City of Collinsville v. Brickey, 242 Pac. 249, that where a municipal corporation discharges sewage into a river or creek, polluting the water of the stream, causing it to become foul and impregnated with noxious and poisonous substances rendering it unfit for domestic or other uses, and thereby creating and maintaining a nuisance which is detrimental to the health, comfort and repose of a lower riparian owner, and diminishes the value of or destroys an established business (such as a dairy business) of such owner, the municipal corporation is liable for damages arising from the maintenance of such nuisance.

NEWS OF THE SOCIETIES

Jan. 10-11 — INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual meeting at St. Louis, Mo.

Jan. 10-14 — AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention and road show at Chicago, Ill.

Jan. 12-15—AMERICAN ENGINEERING COUNCIL. Annual meeting at Washington, D. C.

Jan. 17—AMERICAN INSTITUTE OF CONSULTING ENGINEERS. Annual meeting in New York City.

Jan. 17-19—NATIONAL SAND AND GRAVEL ASSOCIATION. Eleventh annual convention at Cincinnati, O.

Jan. 17-19 — KANSAS WATER WORKS ASS'N. Annual meeting at Lawrence, Kans.

Jan. 19-21—KENTUCKY-TENNESSEE SECTION, A. W. W. A. meeting at Memphis, Tenn.

Jan. 19-21—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting in New York City.

Jan. 24-28—ASSOCIATED GENERAL CONTRACTORS. Annual convention at Asheville, N. C.

Jan. 26-28—IOWA ENGINEERING SOCIETY. Annual meeting at Hotel Fort, Des Moines, Ia.

Feb. 7-8—ROCKY MOUNTAIN SECTION, AMERICAN WATER WORKS ASS'N. Meeting at Denver, Colo.

Feb. 16-18—ASSOCIATION OF STATE HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES. Third annual convention at Atlantic City, N. J.

Feb. 22-24—AMERICAN CONCRETE INSTITUTE. Annual convention at Chicago, Ill.

March 2-4 — CANADIAN SECTION, AMERICAN WATER WORKS ASS'N. Meeting at Ottawa.

March 25—NEW JERSEY SEWAGE WORKS ASS'N. Annual meeting at State House, Trenton.

April — SOUTHEASTERN WATER AND LIGHT ASS'N. Convention at Jackson, Miss.

June 6-11 — AMERICAN WATER WORKS ASSOCIATION. 47th annual convention at Chicago, Ill.

September—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

NEW JERSEY SANITARY ASSOCIATION

The New Jersey Sanitary Association held its 52nd convention at Asbury Park, December 3rd and 4th. It discussed reforestation, water shed conservation, the scientific basis of ventilation, and camp sanitation. Chester G. Wigley, consulting engineer, of Atlantic City was chosen as president for the ensuing year. The latest ideas on ventilation were presented by Prof. Earle B. Phelps, and Herbert H. Morse advocated forced ventilation for public schools. The subject of camp sanitation was discussed by Chas. A. Holmquist, of New York, H. M. Freeburn, of Pennsylvania, and E. R. Carrich and C. K. Blanchard of New Jersey.

A. W. W. A. SECTIONS

The Canadian Section of the American Water Works Association will hold its next meeting at Ottawa on March 2 to 4.

The Rocky Mountain Section will hold a meeting at Denver on February 7 and 8.

FLORIDA SECTION, AMERICAN WATER WORKS ASSOCIATION

Waterworks operators, superintendents and engineers met at Tampa, Florida, November 18th and organized the Florida section of the American Waterworks Association. More than 60 men from all sections of the State attended and took active part in the proceedings. The following officers were elected: Chairman, Anson Squires, Tampa; vice-chairman, Eugene Masters, of St. Augustine; secretary-treasurer, E. L. Filby, Jacksonville. Directors, C. C. Brown, of Lakeland; A. E. Michaels, of Orlando; W. A. Richards, of Daytona Beach; F. W. Lane, of St. Petersburg; L. B. Duane, of Sanford, and F. J. Stewart, of Hollywood. A constitution was adopted and it was decided to hold a spring and fall meeting. Hollywood being selected for the meeting place next April.

Fred J. Stewart, City Engineer of Hollywood, read a paper on the results of the hurricane to the waterworks men, which was followed by considerable discussion as to the need of proper housing of waterworks records and the lack of knowledge of the valve locations and other features of the distribution system. Those present inspected the new Tampa waterworks plant.

TEXAS SCHOOL FOR WATER WORKS MEN

The Texas Section of the Southwest Water Works Association will hold a school for water works men January 24th to 30th. Instruction will be given in providing safe water to consumers, water aeration, the relation of water to health, and sewer problems.

MISSOURI CONFERENCE ON WATER PURIFICATION

The Second Annual Missouri Conference on Water Purification was held in Jefferson City on November 19th and 20th. The membership of this organization comprises those who are connected with the administration, supervision or operation of one or more municipal water purification plants in the State of Missouri. The purpose of this organization is to assist its members in improving the operation of water purification plants for the purpose of securing the best quality of water possible to the end that the health of the public may benefit.

An interesting and instructive program was presented consisting of papers on many water purification problems by several of the best qualified and most experienced chemists and engineers in this particular field. The discussions following each paper indicated a keen interest by those present. Round table discussions concerning many local problems in water purification offered an opportunity for a thorough discussion of questions which had been perplexing to many in attendance.

The increased attendance this year is evidence of the value of those meeting and a growing interest in water purification in Missouri. Forty-eight members and guests were in attendance representing twenty-seven Missouri cities which are supplied by purified water.

The papers and discussions were of such value that it was decided by the Executive Committee to have them mimeographed and the secretary has been instructed to arrange for supplying copies to all members of the Conference and others who might be interested in the proceedings.

At the business meeting the following officers and Executive Committee were elected: Chairman Dr. G. F. Gilkison, chief chemist, Water Department, Kansas City, Mo.; vice-chairman—Dr. A. C. Magill, chemist, Missouri Utilities Company, Cape Girardeau, Mo.; secretary—W. Scott Johnson, chief engineer, State Board of Health, Jefferson City, Mo.

Executive Committee (includes officers): F. Fife, superintendent filtration plant, Kirksville, Mo.; C. E. Heflin, water commissioner, Cameron, Mo., and E. C. M. Burkhart, superintendent waterworks, Macon, Mo.

HIGHWAY RESEARCH BOARD

The sixth annual meeting of this board was held December 2nd and 3rd in Washington, D. C. More than 300 highway engineers, officials and research workers attended the meeting representing 28 states, 25 universities and colleges, and 2 foreign countries. The election of officers and of members of the Executive Committee for 1927 resulted in the election of Prof. G. R. Agg of Iowa State College for the position of Chairman, while Dean A. M. Johnson was retained on the Executive Committee in his place. The officers remained the same as last year, W. H. Connell, Vice Chairman, and Directors, Chas. M. Upham, A. J. Brosseau, H. C. Dickinson, T. H. MacDonald, and William Sparagen; Prof. S. S. Steinberg remaining as Assistant Director.

Abstracts of the reports of the various committees which were read and discussed at the meeting will be found in another part of this issue.

In addition to reports from the research committee dealing with the most important highway research developments during the past year, reports were received from special investigations being conducted under the auspices of the board. Important progress reports were presented on the low-cost improved roads investigation and on the investigation on culvert structures. Considerable interest was shown in the report on the decision of the Executive Committee of the Board to appoint a special Committee on Causes and Prevention of Highway Accidents, presented by Dr. H. C. Dickinson of the U. S. Bureau of Standards, a member of Executive Committee of the Board. The paper on the Methods and Possibilities of Road Soil Investigation, presented by Dr. Charles Terzaghi of the Mass. Institute of Technology, was followed by considerable

valuable discussion. Very interesting addresses were made during the meeting by Dr. George K. Burgess of the U. S. Bureau of Standards and T. H. MacDonald of the U. S. Bureau of Public Public Works

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AMERICAN ROAD BUILDERS' ASSOCIATION
PROGRAM OF TWENTY-FOURTH ANNUAL CONVENTION

At Palmer House, Chicago, January 11, 12 and 13.

After the first general session the meetings will be in two sections, one for engineers and the other for constructors; except for Wednesday morning, a business meeting at 4:30 Wednesday afternoon, and a final general session Thursday afternoon at 2:00.

Tuesday—Governor's Day

10:00 A. M.—Grand Ball Room.
Presiding—Henry G. Shirley, president.

Addresses by Hon. Len Small, Governor of Illinois; Hon. Wm. E. Dever, Mayor of Chicago; and Thos. H. MacDonald, Chief U. S. Bureau of Public Roads.

ENGINEERS' SECTION

12:00 P. M.—Grand Ball Room
Presiding—George F. Schlesinger, director, Ohio Department of Highways and Public Works.

General Subject—Work Preliminary to Construction

"Ultimate Highway Developments, Widening Trunk Lines vs. Adding Parallel Highways," by Ben H. Petty, assistant professor of highway engineering, Purdue University.

"Economic Selection of Type," by H. E. Breed, consulting engineer.

"Local Highway Development," by Colonel Woolsey Finnell, probate judge, Tuscaloosa, Alabama.

"Load Factor as an Element in Design," by T. Warren Allen, chief, Division of Control, U. S. Bureau of Public Roads.

Wednesday—Pan-American Day

10:00 A. M.—Grand Ball Room
Presiding—Diaz Leal, Mexico, and R. Keith Compton, director, Department of Public Works, Richmond, Virginia.

"Canada's Highway Problem," by E. A. James, chief engineer, Toronto and York Roads Commission, Toronto, Canada.

"The Highway Situation in Mexico," by Andres Ortis, Department of Communication, Mexico, D. F.

"Chilean Policy of Road Construction, Maintenance, and Finance," by Benjamin Gonzalez Cohen, secretary to the Chilean Embassy and formerly of the Public Works Division of the Government of Chile, Santiago.

"Road Construction in Cuba," by Manuel Alberto Coroalle, construction engineer for the Cuban Department of Public Works, Havana, Cuba.

Tentative acceptances have been made by Argentine, Peru and Santo Domingo to delegate Engineers to present papers.

2:30 P. M.—Grand Ball Room
Presiding—Cyrus S. Avery, chairman, Oklahoma Department of Highways.

General Subject—Construction

"Latest Improvements in Construction Methods," by B. H. Piepmeier, chief engineer, Missouri State Highway Commission.

"Contract Control and Engineering Service," by Leslie R. Ames, acting highhighway engineer, North Carolina State Highway Commission.

2:00 P. M.—Grand Ball Room
Presiding—Cyrus S. Avery, chairman, Oklahoma Department of Highways.

General Subject—Construction

"Latest Improvements in Construction Methods," by B. H. Piepmeier, chief engineer, Missouri State Highway Commission.

"Contract Control and Engineering Service," by Leslie R. Ames, acting highway engineer, North Carolina State Highway Commission.

"Control of Materials and Results," by H. S. Mattimore, engineer of tests and materials investigation, Pennsylvania Department of Highways.

"Best Method of Control and Payment for Pavement Quantities," by F. E. Kelly, acting chief, Division of Tests, Bureau of Public Roads.

Thursday

10:00 A. M.—Grand Ball Room
Presiding—Thos J. Wasser.

General Subject—Operation and Maintenance

"Selection, Use, and Care of Equipment," by W. H. Root, maintenance engineer, Iowa State Highway Commission.

"Maintenance Ills, Their Diagnosis and Cure," by William H. Connell, acting secretary of highways and engineering executive, Pennsylvania Department of Highways.

"Subgrade Effects Upon Highway Maintenance," by Prof. Frank H. Eno, Ohio State University, Columbus, Ohio.

CONSTRUCTORS' SECTION

Tuesday

2:00 P. M.—Red Lacquer Room.
Presiding—Alan J. Parrish, president, Illinois Association of Highway and Municipal Contractors.

General Subject—Contracting as a Business.

"Contractor and Constructor Defined," by J. H. Ellison, president, Associated General Contractors of America.

"Profit in Industry," by H. A. Wheeler, vice-president, Union Trust Co., Chicago.

"What Is a Fair Profit in Highway Construction?" by George Drake, of Johnson, Drake & Piper, Minneapolis.

"Summary of Observations," by E. A. St. John, president, National Surety Co.

Wednesday

2:00 P. M.—Red Lacquer Room.
Presiding—Edward McGrady, president Associated Pennsylvania Constructors.

General Subject—Practical Operating Methods.

"Estimating and Cost Accounting for Highway Construction," by R. C. Jacobs, president, Juniata Paving Co.

"Value of Engineering Representation in contracting Organizations," by W. M. Wilmore, vice-president, Wabash Construction Co.

"Do Contractors Charge Equipment Rental Sufficient to Pay the Interest on the Investment, Operating and Replacement?" by C. A. Eichelberger, equipment engineer, Pennsylvania Department of Highways.

Thursday

10:00 A. M.—Red Lacquer Room
Presiding—W. J. Wilkinson, president, Northern California Chapter, Associated General Contractors of America.

General Subject—Enlargement of Contractors' Field Benefiting Political Subdivisions.

"Is the Contractor's Loss A Public Gain?" by Robert B. Brooks, director of Streets and Sewers, St. Louis.

"Economic Waste in Construction of Public Work by Day Labor," by Gen R. C. Marshall, general manager, Associated General Contractors.

"Benefits of Highway Contractors Associations to the Contractor, Political Subdivisions and the General Public," by William F. Lodge, former president, Illinois Association of Highway and Municipal Contractors.

Final General Session

2:00 P. M. Grand Ball Room
Presiding—Dr. Fons A. Hathaway, chairman, Florida State Highway Department.

General Subject—Highway Problems

"Best Method of Control and Payment for Pavement Quantities," by J. E. Ellison, first assistant commissioner and chief engineer, Minnesota State Highway Department.

"Should Engineers' Estimates Be Made Public?" by Arthur W. Brandt, commissioner of Highways, State of New York.

"Practical Qualifying of Bidders on Public Works," by Frank T. Sheets, chief engineer, Division of Highways, State of Illinois.

"Increasing Efficiency in Highway Construction Organizations," by J. L. Harrison, highway engineer, U. S. Bureau of Public Roads.

LIST OF EXHIBITORS AT 1927 ROAD SHOW

This list was complete up to December 13. There may be some additions before the show opens.

A. C. Spark Plug Co., Flint, Mich.
Acme Road Machinery Co., Frankfort, N. Y.
Adams & Co., J. D., 217 S. Belmont Ave., Indianapolis, Ind.
Ajax Wrench Corp., 4314 Snyder Ave., Brooklyn, N. Y.
Allan Wood, Iron & Steel Co., 1800 Widener Bldg., Philadelphia, Pa.
American Blue Print Co., 445 Plymouth Court, Chicago, Ill.
American Bosch Magneto Corp., Springfield, Mass.
American Casting Co., P. O. Drawer 591, Birmingham, Ala.
American Cement Machine Co., Keokuk, Ia.
American City Magazine, 443 Fourth Ave., New York, N. Y.
American Gas Accumulator Co., Elizabeth, N. J.
American Malleable Castings Assn., 2013 Union Trust Bldg., Cleveland.
American Manganese Steel Co., Chicago Heights, Ill.
American Steam Pump Co., Battle Creek, Mich.
American Steel & Wire Co., 208 S. La Salle St., Chicago, Ill.
American Tar Products Co., Union Trust Bldg., Pittsburgh, Pa.
American Vibrolithic Corp., 933 Insurance Ex. Bldg., Des Moines, Ia.
American Wood Preservers' Assn., Service Bureau, Chicago, Ill.
Ames Shovel & Tool Co., Ames Bldg., Boston, Mass.

Amiesite Asphalt Co. of America, 235 S. 15th St., Philadelphia, Pa.
Anthony Co., Streator, Ill.
Arkell Safety Bag Co., 120 Broadway, New York, N. Y.
Armco Culvert & Flume Mfrs. Assn., Middletown, O.
Asphalt Assn., The, 441 Lexington Ave., New York, N. Y.
Asphalt Block Pavement Co., Ohio Bldg., Toledo, O.
Associated Pa. Constructors, Masonic Temple, Harrisburg, Pa.
Atlas Engineering Co., 31st and Galena Sts., Milwaukee, Wis.
Atlas Lumnite Cement Co., 25 Broadway, New York, N. Y.
Austin Machinery Corp., Muskegon, Mich.
Austin Mfg. Co., 400 N. Michigan Ave., Chicago, Ill.
Austin-Western Road Machinery Co., 400 N. Michigan Ave., Chicago, Ill.
Autocar Co., The, Ardmore, Pa.
Automatic Signal & Sign Co., 1014 S. Michigan Ave., Chicago, Ill.
Avery Power Machinery Co., Peoria, Ill.
Baker Mfg. Co., Springfield, Ill.
Barber Asphalt Co., 1600 Arch St., Philadelphia, Pa.
Barber-Greene Co., Aurora, Ill.
Barnes Mfg. Co., Mansfield, O.
Barrett Co., 40 Rector St., New York, N. Y.
Bassick Mfg. Co., 2650 N. Crawford Ave., Chicago, Ill.
Bates Mfg. Co., Henderson Ave., Joilet, Ill.
Bay City Dredge Works, Bay City, Mich.
Beaver Mfg. Co., 35 25th St., Milwaukee, Wis.
Bosch Magneto Co., Inc., Robert, 123 W. 64th St., New York, N. Y.
Belle City Mfg. Co., Racine, Wis.
Blaw-Knox Co., Pittsburgh, Pa.
Brookville Locomotive Co., Brookville, Pa.
Brown Hoisting Machinery Co., 4403 St. Clair Ave., Cleveland, O.
Brown-Lipe Gear Co., Syracuse, N. Y.
Browning Crane Co., 16226 Waterloo Rd., N. E., Cleveland, O.
Buckeye Traction Ditcher Co., Findlay, O.
Buda Co., The, Harvey, Ill.
Buffalo-Springfield Roller Co., Springfield, O.
Buhl Co., The, 407 S. Dearborn St., Chicago, Ill.
Bunting Brass & Bronze Co., Toledo, O.
Burch Plow Works Co., Crestline, O.
Bucyrus Co., South Milwaukee, Wis.
Butler Bin Co., Waukesha, Wis.
Butler Mfg. Co., 424 Hanna Bldg., Cleveland, O.
Byers Machine Co., Ravenna, O.
Carey Co., The Philip, Cincinnati, O.
Carr Fastener Co., 31 Ames St., Cambridge, Mass.
Carter Co., Ralph B., 126 Chambers St., New York, N. Y.
Caterpillar Tractor Co., Peoria, Ill.
Celite Products Co., 11 Broadway, New York, N. Y.
Central Alloy Steel Corp., Massillon, O.
C. H. & E. Mfg. Co., 254 Mineral St., Milwaukee, Wis.
Chain Belt Co., 736 Park St., Milwaukee, Wis.
Chausse Oil Burner Co., 1227 W. Beardsley Ave., Elkhart, Ind.
Chicago Automatic Conveyor Co., Old Colony Bldg., Chicago, Ill.
Chicago Pneumatic Tool Co., 572 W. Randolph St., Chicago, Ill.
Chilton Class Journal Co., 56th and Chestnut Sts., Philadelphia, Pa.
Clay Products Assn., 913 Chamber of Commerce Bldg., Chicago, Ill.
Cleveland Tractor Co., East 193rd St., Cleveland, O.
Cleveland Trencher Co., 20100 St. Clair Ave., Euclid, O.
Climax Engineering Co., Clinton, Ia.
Clyde Iron Works Sales Co., 29th Ave. West, Duluth, Minn.
Concrete Steel Co., 42 Broadway, New York, N. Y.
Concrete Surfacing Machinery Co., 4669 Spring Grove Ave., Cincinnati, O.
Conneaut Shovel Co., Conneaut, O.
Construction Machinery Co., Waterloo, Ia.
Continental Motors Corp., 12801 Jefferson Ave., Detroit, Mich.
Continental Products Co., East 222nd St., Euclid, O.
Contractors' and Engineers' Monthly, 443 Fourth Ave., New York, N. Y.
Cummer & Son Co., F. D., 2016 Keith Bldg., Cleveland, O.
Curtis Pneumatic Machinery Co., Wellston P. O., St. Louis, Mo.
Cyclone Fence Co., Waukegon, Ill.
D. A. Lubricant Co., Indianapolis, Ind.
Deister Concentrator Co., 901 Glasgow Ave., Fort Wayne, Ind.
Domestic Engine & Pump Co., Shippensburg, Pa.
Dow Chemical Co., Midland, Mich.
Dravo Equipment Co., Penn Ave., Pittsburgh, Pa.
Differential Steel Car Co., Findlay, O.
Eagle Iron Works, 129 Holcomb Ave., Des Moines, Ia.
Eaton Axle & Spring Co., Cleveland, O.
Eisemann Magneto Corp., 165 Broadway, New York, N. Y.
Electric Wheel Co., Walton Heights, Quincy, Ill.
Elgin Sales Corp., 501 Fifth Ave., New York, N. Y.
Engineering and Contracting, 221 E. 20th St., Chicago, Ill.
Engineering News-Record, 475 Tenth Ave., New York, N. Y.
Equipment Corp. of America, 11 S. La Salle St., Chicago, Ill.
Erie Malleable Iron Co., Van Metal Wheel Division, Erie, Pa.
Erie Steam Shovel Co., Erie, Pa.
Erie Steel Construction Co., Erie, Pa.
Essco Mfg. Co., Peoria, Ill.
Etnyre & Co., E. D., Oregon, Ill.
Euclid Crane & Hoist Co., Euclid, O.
Everhot Mfg. Co., 619 S. 10th St., Maywood, Ill.
Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.
Farrell-Cheek Steel Foundry Co., Sandusky, O.
Flory Mfg. Co., S., Market and Main Sts., Bangor, Pa.
Foos Gas Engine Co., Springfield, O.
Foote Co., Inc., Nunda, N. Y.
Four Wheel Drive Auto Co., Clintonville, Wis.
French & Co., A. W., 8440 Lowe Ave., Chicago, Ill.
French & Hecht, Davenport, Ia.
Fruehauf Trailer Co., 10940 Harper Ave., Detroit, Mich.
Full-Crawler Co., 500 Clinton St., Milwaukee, Wis.
Fuller & Johnson Mfg. Co., Madison, Wis.
Galion Allsteel Body Co., Galion, O.
Galion Iron Works & Mfg. Co., Galion, O.
Garford Truck Co., Lima, O.
General Excavator Co., Marion, O.
General Motors Truck Co., 5801 W. Dickens Ave., Chicago, Ill.
Gerlinger Electric Steel Casting Co., West Allis, Wis.
Gilbert Mfg. Co., Aberdeen, S. D.
Godwin Co., Inc., W. S., Race and McComas Sts., Baltimore, Md.
Good Roads Equipment Corp., 1107 City Centre Bldg., Philadelphia, Pa.
Goods Roads, 53 W. Jackson Blvd., Chicago, Ill.
Goods Roads Co., Inc., Upper Darby P. O., Philadelphia, Pa.
Goods Roads Machinery Co., Inc., Kennett Square, Pa.
Grasselli Chemical Co., Guardian Bldg., Cleveland, O.
Hadfield-Penfield Steel Co., Bucyrus, O.
Haiss Mfg. Co., George, 141st St., New York, N. Y.
Harnischfeger Sales Corp., 38th and National Aves., Milwaukee, Wis.
Hastings Pavement Co., 25 Broad St., New York, N. Y.
Hayward Co., 50 Church St., New York, N. Y.
Heil Co., 26th and Montana Aves., Milwaukee, Wis.
Heltzel Steel Form & Iron Co., Warren, O.
Hercules Corp., Evansville, Ind.
Hercules Motors Corp., Canton, O.
Highland Body Mfg. Co., Elmwood Pl., Cincinnati, O.
Highway Trailer Co., Edgerton, Wis.
Hotchkiss Steel Products Co., Binghamton, N. Y.
Huber Mfg. Co., Marion, O.
Hug Co., The, Highland, Ill.
Hughes-Keenan Co., P. O. Drawer 398, Mansfield, O.
Humphryes Mfg. Co., Mansfield, O.
Hvass & Co., Inc., Chas., 508 E 19th St., New York, N. Y.
Hyatt Roller Bearing Co., Newark, N. J.
Hydraulic Hoist Mfg. Co., 292 Walnut St., St. Paul, Minn.
Ideal Concrete Machinery Co., 5000 Spring Grove Ave., Cincinnati, O.
Indiana Truck Corp., Marion, Ind.
Industrial Works, Bay City, Mich.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
Insley Mfg. Co., Indianapolis, Ind.
International Harvester Co. of America, 606 S. Michigan Ave., Chicago, Ill.
International Motor Co., 25 Broadway, New York, N. Y.
International Trade Press, Inc., 542 Monadnock Block, Chicago, Ill.
Jackoboice, Edw. J., 136 Mt. Vernon Ave., N. W., Grand Rapids, Mich.
Jaeger Machine Co., 520 Dublin Ave., Columbus, O.
Jensen, E. C., Box 201, Cedar Rapids, Ia.
Johnson Co., C. S., Champaign, Ill.
Jones Superior Machine Co., 1258 W. North Ave., Chicago, Ill.
Kalman Steel Co., 410 N. Michigan Ave., Chicago, Ill.
Kensington Steel Co., 505 Kensington Ave., Chicago, Ill.
Kentucky Rock Asphalt Co., 718 M. E. Taylor Bldg., Louisville, Ky.
Keystone Driller Co., Beaver Falls, Pa.
Killefer Mfg. Co., Box 606, Huntington Park, Cal.
Kinney Mfg. Co., 3529 Washington St., Boston, Mass.
Knickerbocker Co., Jackson, Mich.
Koehring Co., 31st St. and Concordia Ave., Milwaukee, Wis
K. P. Products Co., 60 Beaver St., New York, N. Y.
Kwik-Mix Concrete Mixer Co., Port Washington, Wis.
Lakewood Engineering Co., Cleveland, O.
LaPlant-Choate Mfg. Co., Cedar Rapids, Ia.
Lauson Mfg. Co., John, New Holstein, Wis.
Leach Co., Oshkosh, Wis.
Le Roi Co., 60th and Mitchell Sts., Milwaukee, Wis.
Leschen & Sons Rope Co., A., 5909 Kennerly Ave., St. Louis, Mo.
Link-Belt Co., 300 W. Pershing Road., Chicago, Ill.
Little Red Wagon Mfg. Co., Omaha, Neb.
Littleford Bros., 451 E. Pearl St., Cincinnati, O.
Lufkin Rule Co., Saginaw, Mich.
Macleod Co., The, Bogen St., Cincinnati, O.
Macwhyte Co., Kenosha, Wis.
Manufacturers' Record, Commerce and Water Sts., Baltimore, Md.
Marion Steam Shovel Co., Marion, O.
Markman, John, Box 231, Forreston, Ill.
Marlow, A. S., Lincoln Park, N. J.
Marsh-Capron Co., 11 S. La Salle St., Chicago, Ill.
McKiernan-Terry Drill Co., 15 Park Row, New York, N. Y.
McMyler Interstate Co., Bedford, O.
Meadows, Inc., W. R., 2-8 Kimball St., Elgin, Ill.
Metal Forms Corp., 1436 Booth St., Milwaukee, Wis.
Metalweld Service Corp., 2617 Hunting Park Ave., Philadelphiaa, Pa.
Miami Trailer-Scraper Co., Troy, O.
Milburn Co., Alexander, 1416 W. Baltimore, St., Baltimore, Md.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Monarch Tractors Corp., Springfield, Ill.
Morris Machine Works, Baldwinsville, N. Y.
Morrow Mfg. Co., Wellston, O.
Mundie Mfg. Co., 501 Brunner St., Peru, Ill.
National Lime Assn, 918 G St., N. W., Washington, D. C.
National Paving Brick Mfrs. Assn., 830 Engrs. Bldg., Cleveland, O.
National Steel Fabric Co., Union Trust Bldg., Pittsburgh, Pa.
Northern Conveyor & Mfg. Co., Janesville, Wis.
Northfield Iron Co., Northfield, Minn.
Northwest Engineering Co., 28 E. Jackson Blvd., Chicago, Ill.
Novo Engine Co., Lansing, Mich.
O'Connell Motor Truck Co., 2381 Archer Ave., Chicago, Ill.
Oil Jack Co., Inc., 110 W. 40th St., New York, N. Y.
O. K. Clutch & Machinery Co., Columbia, Pa.
Olsen Testing Machine Co., Tinius, 500 N. 12th St., Philadelphia, Pa.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago, Ill.
Osgood Co., Marion, O.
Oshkosh Motor Truck Mfg. Co., Oshkosh, Wis.
Owen Bucket Co., 6001 Breakwater Ave., Cleveland, O.
Orr & Sembower, Reading, Pa.
Page Steel & Wire Co., 929 Connecticut Ave., Bridgeport, Conn.
Parsons Co., Newton, Ia.
Perforated Roller Works, Kankakee, Ill.
Perry Co., Sidney, O.
Pit & Quarry, 538 S. Clark St., Chicago, Ill.
Pittsburgh Testing Laboratory, Pittsburgh, Pa.
Portland Cement Assn., 33 W. Grand Ave., Chicago, Ill.
Public Works Journal Corp., 243 W 39th St., New York, N. Y.
Racine Radiator Co., Racine, Wis.
Rail Steel Bar Assn., 111 W. Jackson Blvd., Chicago, Ill.
Ransome Concrete Machinery Co., Dunellen, N. J.

Rawls Machine & Mfg. Works, 1412 N. Halsted St., Chicago, Ill.
Rennoids Equipment Co., 307 N. Michigan Ave., Chicago, Ill.
Republic Motor Truck Co., Inc., Alma, Mich.
Rex-Watson Corp., Canastota, N. Y.
Riehle Bros. Testing Machine Co., 1424 N. 9th St., Philadelphia, Pa.
Rock Products, 542 S. Dearborn St., Chicago, Ill.
Rome Mfg. Co., Rome, N. Y.
Russell & Co., The, Massillon, O.
Russell Grader Mfg. Co., 2037 University Ave., S. E., Minneapolis, Minn.
Ryan Car Co., 310 S. Michigan Ave., Chicago, Ill.
Ryerson & Son, Inc., Joseph T., 2558 W. 16th St., Chicago, Ill.
Sauerman Bros., Inc., 438 S. Clinton St., Chicago, Ill.
Schramm, Inc., West Chester, Pa.
Seaverns Co., James B., 1315 S. Oakley Ave., Chicago, Ill.
Service Motors, Inc., Garfield St., Wabash, Ind.
Servicized Products Co., 6051 W. 65th St., Chicago, Ill.
Shaw-Enochs Tractor Co., 2416 University Ave., S. E., Minneapolis, Minn.
Simons Paint Spray Brush Co., 17 Maryland Ave., Dayton, O.
Simplicity Engineering Co., 209 S. Oak St., Durand, Mich.
Sivyer Steel Casting Co., 37th Ave. and Mitchell, Milwaukee, Wis.
Smith Co., The T. L., 1125 32d St., Milwaukee, Wis.
Smith Engineering Works, Lake Blvd. and Holton St., Milwaukee, Wis.
Snap-On Wrench Co., 14 E. Jackson Blvd., Chicago, Ill.
Speeder Machinery Corp., Fairfield, Ia.
Splitdorf Electrical Co., 392 High St., Newark, N. J.
Solvay Process Co., 40 Rector St., New York, N. Y.
Standard Scale & Supply Corp., 412 1st Ave., Pittsburgh, Pa.
Star Drilling Machine Co., Washington St., Akron, O.
Stover Mfg. & Engine Co., Freeport, Ill.
Streich & Bro. Co., A., Oshkosh, Wis.
Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill.
Superior Body Corp., Marion, Ind.
Talbot-Flood Mfg. Co., 521 Dwight Bldg., Kansas City, Mo.
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Texas Co., The, Asphalt Sales Dept., 17 Battery Pl., New York, N. Y.
Thew Shovel Co., 1300 E. 28th St., Lorain, O.
Timken-Detroit Axle Co., 100-400 Clark Ave., Detroit, Mich.
Timken Roller Bearing Co., Canton, O.
Toledo Pressed Steel Co., Toledo, O.
Toledo Wheelbarrow Co., Toledo, O.
Tractor Grip Wheel Co., 2237 Water Works Drive, Toledo, O.
Truscon Steel Co., Youngstown, O.
Twin Disc Clutch Co., 1328 Racine St., Racine, Wis.
Universal Crane Co., 914 Swetland Bldg., Cleveland, O.
Universal Crusher Co., 625 Cedar Rapids, Ia.
Universal Motor Co., 39 St., Oshkosh, Wis.
Waukesha Motor Co., Waukesha, Wis.
Wausau Iron Works, Wausau, Wis.
Wehr Co., 533 30th St., Milwaukee, Wis.
Western Crucible Steel Casting Co., 2833 Grand Ave. S., Minneapolis, Minn.
Western Wheeled Scraper Co., Aurora, Ill.,
White Co., The, 842 E. 79th St., Cleveland O.
Whitehead & Kales Co., Detroit, Mich.
Wiard Plow Co., Batavia, N. Y.
Wickwire Spencer Steel Co., 41 E. 42nd St., New York, N. Y.
Williams Co., G. H., Erie, Pa.
Williams Patent Crusher & Pulverizer Co., St. Louis, Mo.
Williamsport Wire Rope Co., 122 Michigan Ave., Chicago, Ill.
Wisconsin Motor Mfg. Co., 44th and Burnham Sts., Milwaukee, Wis.
Wood Hydraulic Hoist & Body Co., 3136 S. Wabash Ave., Chicago, Ill.
Zenith-Detroit Corp., Detroit, Mich.
Zenith Shovel Co., 9 S. Clinton St., Chicago, Ill.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS

This association has adopted a resolution authorizing the president to "appoint a committee to determine the many ways and means of bringing about the cooperation of the American Road Builders Association and the American Association of State Highway Officials in the solution of the many highway problems now confronting us and in furthering the interest of the highway industry." This resolution was prefaced by a recital of the recognition by this society of the value of the work done by the American Road Builders' Association and of the fields in which the interests of both associations are mutual.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS

The seventh annual conference of this association will be held at the Statler Hotel, St. Louis, Mo., on January 10th and 11th. The subjects presented for discussion are as follows: "The Street Department—The Service It Renders to Its Community"; presented by W. J. Galligan. "Rubbish and Ash Collection"; presented by Martin H. Zink; "Sewer Maintenance and Catch Basin Cleaning"; presented by George E. McGrath. "Type of Pavement and Its Relation to Cleaning"; presented by John Klorer. "Collection and Disposal of Garbage"; presented by W. H. Carrigg. "Fighting Snow"; presented by L. W. Herzog. "The Maintenance of Unimproved Streets in Cities"; presented by George H. Sandenburgh. "Street Cleaning"; presented by J. G. Tomson. "Should the Truck and Automobile Share in Expense of Maintaining City Pavements?" presented by Jno. C. Shaw. "Street Repairs and Street Marking"; presented by Walter Heimbuecher. "Street Parking as a Municipal Problem"; by Robert B. Brooks. "Sidewalks—Method to Compel Construction and Maintenance"; presented by P. J. Hurtgen. "How to Secure Cooperation in Preventing the Littering of Streets and Alleys"; presented by G. R. Thompson. "Methods and Advantages of Uniform Cost Keeping"; presented by B. C. Harvey. "How to Obtain Efficiency in the Personnel of Your Department"; round table discussion.

CIVIL SERVICE EXAMINATIONS

Assistant Physicist. Applications received up to January 11th, 1927. To fill vacancies in the Bureau of Standards and the Bureau of Mines, and positions requiring similar qualifications. Entrance salary $2,400 a year. Advancement after six months probationary period depends upon individual efficiency, usefulness and occurence of vacancies. Competitors to be rated on optional subjects of heat, electricity, mechanics, optics, radio, physical metallurgy, or any other specialized work in the field of physics.

Other applications will be received until January 4th for vacancies in the Naval Air Station at Lakehurst, N. J. at $8.08 per day. Duties-calibration and operation of complicated and very sensitive and delicate instruments in daily use on board the helium-inflated air craft and in the helium repurification plant. Applicants must have degree from college or university including mathematics through elementary differential equations, and physics, and at least one year subsequent experience in physical or engineering laboratory work, or post-graduate work in college.

Engineering Aid. Applications received until January 15th. To fill vacancies in Interstate Commerce Commission. Entrance salary $1,680 with possible advancement after six months probationary period. Must have completed at least three-year course in civil, mechanical, structural or highway engineering or two years of such course and one year of practical experience. Duties, calculation and classification of land areas and related work.

Junior Patent Examiner. Applications received until January 29th. To fill vacancies in the Patent Office at Washington, D. C. Entrance salary $1860. Duties to perform elementary, scientic or technical work in the examination of applications for patents; to see what the alleged inventor thinks he has produced that is new and to see that the disclosure is complete; and to investigate the prior art as represented by patents already granted in the United States and various foreign countries and by the description in technical literature. Competitors will be rated on physics, mechanical drawing, technics, mathematics and French and German.

Junior Engineer and Deck Officer.—Applications received until March 29, 1927. Salary $2,000 a year. To fill vacancies in the Coast and the Geodetic Survey. As vacancies occur in the lower commissioned grades they will be filled by the promotion of those who, after at least six months' experience in the temporary grade of junior engineer and deck officer, show ability to perform the work of the service and pass a satisfactory physical examination. Commissioned officers are subject to military duty in time of national emergency, when they may be transferred by executive order to either the army or the navy.

PERSONALS

Irving E. Mathews has been appointed Superintendent of the Water Bureau of Rochester, New York in place of Beekman C. Little, who several months ago resigned to serve as secretary of the American Waterworks Association. Mr. Mathews had for several years been assistant in the Rochester Engineering Department.

Col. Merritt H. Smith, for the past twelve years chief engineer of the Department of Water Supply, New York City, died Dec. 8th, aged 64 years. Following several months of illness he had retired from his position a few days before his death, after forty years of service to the city, mostly in connection with its water supply and paving.

NEW CATALOGS

SULLIVAN DRILL SHARPENER
Sullivan Machinery Company, Chicago. A 32-page bulletin describing machine for hammer-forging drill bits and shanks.

OSGOOD ONE-YARD HEAVY DUTY SHOVEL
The Osgood Company, Marion, Ohio. A 24-page bulletin describing, with illustrations, one-yard heavy-duty gas or electric shovel, adaptable as crane, dragline, and back hoe.

GOOD ROADS SNOW PLOW
The Rood Roads Machinery Company, Kennett Square, Pa. A four-page folder describing the new "Hi-speed" snow plow.

ELECTRIC TRAFFIC SIGNALS
The Crouse-Hinds Co., Syracuse, N. Y. A 22-page reprint of progress report of the National Highway Traffic Association Committee on Electric Traffic Signals and Intersections, with diagrams and photographs.

THE MOTOR PARKING PROBLEM
Hockenbury System, Inc., Harrisburg, Pa. Describes Multi-floor garages embodying the "d'Humy motoramp," a patented principle of building design. Twelve pages with photographs of installation.

OUT OF THE MUD WITH LIME
National Lime Association, Washington, D.C., 16-page illustrated bulletin showing steps involved in using lime on earth roads to eliminate ruts.

CLETRAC CRAWLER TRACTORS
Cleveland Tractor Company, Cleveland, Ohio. A four page folder describing adaptability for plant and factory uses.

TRUSCON SOLID STEEL WINDOWS
The Truscon Steel Company, Youngstown, Ohio. A 24 page catalogue describing solid steel double-hung windows, with abundant diagrams showing types and methods of installation.

HYDROGEN ION CONTROL
La Motte Chemical Products Company, Baltimore, Md. A 32 page catalog giving treatise on colorimetric determination of hydrogen ion control, as well as a list of the materials and equipment furnished by the company for use of this new method.

WACKER DRIVE, CHICAGO
An 18-page souvenir book distributed free by the contractor, the Mid-Continent Construction Co., during the official opening of the drive. Describes and illustrates the plans and the construction methods, and gives history of the improvement.

COPPER BEARING STEEL
Truscon Steel Company, Youngstown, Ohio. 16 page pamphlet describing properties and the various uses made of this rust-resisting metal.

EDWARDS ROTARY SNOW PLOW
Large folder with photographs of plow and work done, and details of construction.

CAMERON CENTRIFUGAL PUMPS
Ingersoll-Rand Company, New York City. 24 page bulletin describing Cameron single-stage, double-suction, volute pump, with numerous illustrations of pumps and of parts.

FULTON DIESEL ENGINE
Fulton Iron Works Company, St. Louis. 26 page catalogue, abundantly illustrated, giving advantages and describing principles and the details of construction.

HOISTING AND HAULING
Sullivan Machinery Company, Chicago, Ill. 16 pages of photographs, with cap-

(*Continued on page* 54)

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

IMPROVEMENT FOR DRAGLINE EXCAVATORS

The Koehring Company, Milwaukee, has recently announced an improvement in the shape of a swivel type of boom point fairlead on its dragline excavators where sloped bank work is necessary. By permitting the fairlead sheave to swing at will, the cable pulls directly over the center line of the sheave at all times, irrespective of the position of the bucket. All cross pull and friction between the sheave face and the cable is eliminated. In addition to giving longer life to the cable, it saves the swing clutches and increases the speed of operation. The operator finds it possible to drop his bucket on the right spot without giving his attention to the exact position of the boom.

This improvement consists of a swivel sheave casting which journals in a cylindrical bearing. The bearing is rigidly supported by the boom point yoke, which in turn is bolted to the tip of the structural steel boom. This type of point is interchangeable with the regular boom point construction and can easily be put on in the field.

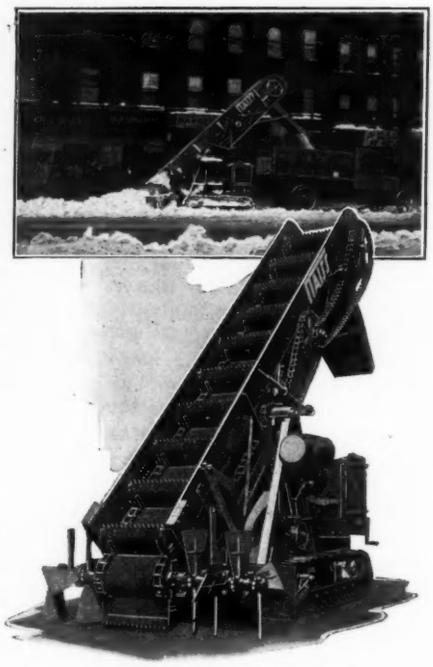
HUBER 5-TON ROLLER

The Huber Manufacturing Company, of Marion, Ohio, has announced that it will begin delivering this winter 5-ton and 7-ton 4-cylinder motor rollers built along the same lines as the 10-ton roller which they introduced about five years ago. This smaller roller is powered with a Waukesha 4-cylinder engine developing about 30 h. p., which is equipped with circulating pump, high tension magneto, oil spray air cleaner and governor control. The transmission gears are of chrome nickel steel, and all gears are enclosed in a heavy cast iron case perfectly dust and dirt proof and run in a bath of oil. The only plain bearings are the front rolls, which are bushed with bronze; all the others, including the rear axle, are hung in heavy duty ball or roller bearings. A built-in spur gear differential is a feature of the transmission, this throwing the same pulling strain on both drive rollers, whether on straight pull or on a curve.

A feature of this roller is the method of control. It has two speeds forward and two speeds reverse, the travel being at the same speed in each direction. A single control lever shifts heavy frictions, one for the forward motion and one for the reverse, without shifting of gears. The manufacturer claims that with this control, change from forward to reverse can be made quickly, and that the friction wear is distributed through three clutches—the master clutch, the forward and the reverse clutches, thus reducing clutch troubles to a minimum. The small roller will have scarifier attachment; also a grader blade attachment will be available if wanted.

THE HAISS SNOW LOADER

The George Haiss Manufacturing Co., New York City, is bringing out an improved, high powered model, snow loader—a creeper tread mounted machine with a 37 horsepower Waukesha motor and a corresponding heavy set of transmission gears and clutches, all housed in one case and running in oil. This, and in fact the whole chassis, is identical with the construction of the Haiss bucket loader. The snow elevator, however, is entirely different from the previous Haiss machines. It is a flight or scraper conveyor with the high flights—built as heavy as the buckets used for crushed stone—½-inch steel plate with toothed reinforcing edges and side plates which also brace the bottom of each flight unit. These flights are shaped to prevent dry snow from rolling back over their upper edges, and bolted at each side to endless chain belts which carry them up the elevator at a speed of 140 feet per minute. Each flight, as it comes in contact with the bottom of the snow pile, presents its tooth edge at the most effective angle for cutting effect. The loader has revolving paddles for feeding materials from the sides toward the center of the machine. In addition, it has a clean-up scraper immediately behind the paddles to push any spillage back into the pile which is being loaded.

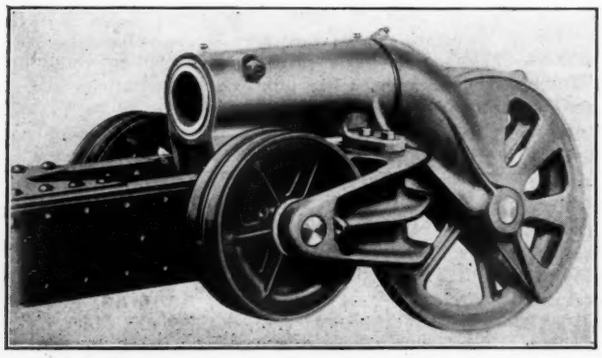


HAISS SNOW LOADER

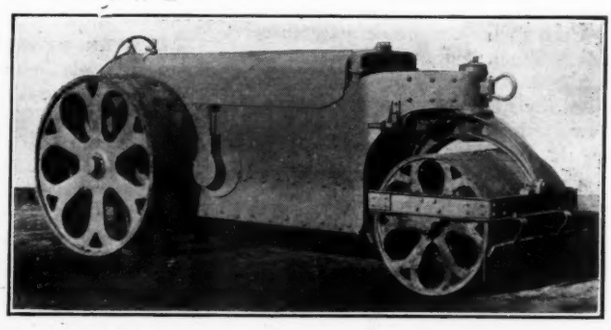
The manufacturer claims that this snow loader can dig into frozen snow piles. After the 7-inch snow fall in December in New York, one of these loaders kept a fleet of 5 eight-yard trucks busy removing snow, which it dug from windrows two feet high and seven or eight feet wide which had been formed by snow plows. The loader was idle two-thirds of the time and could have kept ten trucks busy. Trucks were loaded in from 50 to 80 seconds, or at a rate of approximately ten yards a minute.

THE FUNDOM SHOVEL

The Fundom Hoist and Shovel Company, Lima, Ohio, has brought out a shovel which it claims has fewer parts than any other with a resulting minimum loss in friction. It is recommended for road building, quarry operation, clay, sand and gravel pits, and general excavation. For the gasoline shovel a Fordson tractor is used for power, and



KOEHRING BOOM POINT FAIRLEAD



NEW 5-TON MODEL HUBER 4-CYLINDER MOTOR ROLLER

for the electric shovel a 25 h. p. 900 R.P.M. heavy-duty motor of good standard make. Alemite high pressure lubrication is used on all bearings. The clutches are double faced and Thermoid lined. The boom is of 8-inch channel reinforced with plates and ties and 12 feet long. The mast consists of two 6-inch channel members fastened at the lower end on a yoke casting, while the upper end supports a masthead casting. The crowding mechanism is operated by a clutch driving a link chain to support the shaft, which is provided with two steel pinions meshing with steel racks on the dipper handle. All high-speed shafts have Timken roller bearings, while other bearings have phosphor bronze bushings. Three hand levers and two foot pedals control all digging operation. The boom travels a three-quarter circle. The capacity is said to be ten to thirty cubic yards an hour, depending upon the working conditions. The capacity of the dipper is one-third yard when filled level. The crawls have a total length of 9 feet 6 inches, and are driven from the Fordson tail screw. The length over all without boom is 14 feet and width over all 6 feet 8 inches. A boom extension 11 feet long gives a total length of 22 feet used for crane with hook, clamshell, any kind of dragline or backfiller, also all general hoisting purposes. An excavator attachment with automatic self-dumping bucket operating on trolley is used for sewer and drainage trenching. Buckets used are 18 inches, 24 inches or 30 inches wide.

KILLEFER ROAD DISCS

The Killefer road disc is a tool used to remove corduroy or humps from asphalt macadam surfaces. It smooths off the high spots and when these have been whittled into pulverized material this is redistributed by the grader, or some other tool used to crown up the surface, after which it is rolled into conformity with the surface contour. If the whittlings are light, they are swept off and the roads put at once into service. The disc can be drawn by any tractor of 20 drawbar horsepower, with a grader trailed behind.

The discs are arranged in four gangs of twelve discs each. They are 20 inches in diameter and spaced 2 inches apart in the gang. Scrapers are provided between discs. The discs are mounted on heavy square steel bars which are machined at the ends for long bearings. They are mounted in cast-iron bushings machined to proper fit and are protected by dust proof housings. The discs can be resharpened after the edges have worn down, by rolling the edges, and this can be done many times before it is necessary to discard the blade. The total width of cut made by the machine is 45 inches.

The implement is carried on two rear wheels and a pivotted front axle with two wheels. Each rear wheel has a separate axle. All axles are independently controlled by lifting screws, thus utilizing the principle of three point suspension and allows the disc gangs to be tilted to the desired angle to conform to surface contour. The cutting edges may be lowered to cut two inches below grade or lifted ten inches above grade. The weight of the number 4 road disc is 6,850 pounds.

LINK BELT VIBRATING SCREEN

The Link Belt Company, Chicago, Illinois, announces a new ball-bearing vibrating screen. The screen is a mechanically operated device with only one moving part, which rotates in large, over-size ball bearings. It has no cams, springs, striking blocks, or levers to adjust or remove. A shaft, driven at suitable speed from any source of power, is thrown out of balance by adjustable counterweights and imparts vibrations to the screen box on which it is mounted. A feed hopper attached to the receiving end of the screen box vibrates with it, controls the feed, and uniformly spreads the material over the screening surface. For screening materials containing small particles such as brick clay, etc., the vibrating feed hopper is fitted with a counterweighted swinging feed gate. This is said to make it easy to receive a non-uniform feed and spread the material over the width of the screen cloth at just the right speed.

Any mesh of screen can be used. Two flanged clamp plates are used for stretching the screen cloth tight in the screen box, clamping the cloth to its deck, eliminating wear of the screen box side frames, and preventing a leakage along the side edges. A longitudinal vibrator strip assists the screening action by imparting raps to the cloth, minimizing wear and binding. The screen cloths used are the standard width, which can be obtained in rolls, and the screen cloth can readily be renewed in the box when it is worn out. There are five standard sizes— 2x5 feet, 3x5 feet, 4x5 feet, 3x8 feet and 4x8 feet; and each size can be furnished with either one or two screening surfaces.

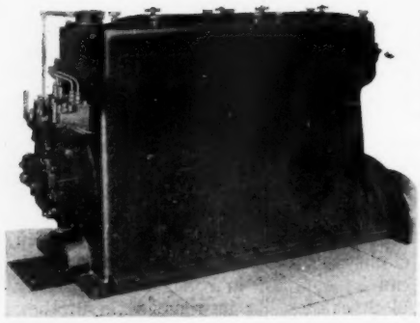
THE FOOS DIESEL ENGINE

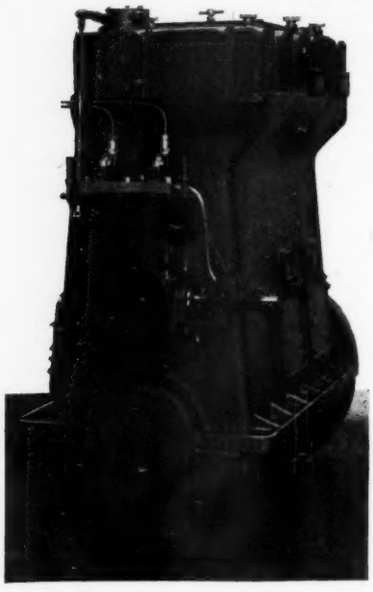
The Foos Gas Engine Company, Springfield, Ohio, has brought out a Diesel engine with several new features to meet the specific requirements of the industrial field and also some of the stationary power field. The entire engine, including the flywheel, is enclosed, no moving part being visible except the driving end of the crank shaft. The purpose of this is to keep the working parts, bearings, etc., free from any dust, dirt or foreign matters when used with shovels, cranes, industrial locomotives, etc. It also protects the machine from large objects falling into it and prevents the lubricating oil from leaking from any part of the machine. Large cover plates are provided on both sides opposite the crank throws to give access to the lower parts of the main cylinder frame, bearings, etc., while the top of the engine is provided with cover plates for inspection of the head, valves and valve mechanism.

This industrial Diesel is a 4-cylinder engine operating on the full Diesel combustion cycle. It has a plain Diesel combustion chamber, into which the fuel is injected vertically at the axis of the cylinder. Complete atomization of the fuel is secured by the use of the mechanical injection principle used on

KILLEFER DISC IN OPERATION

LINK BELT VIBRATING SCREEN





FOOS GASOLINE ENGINES

the larger stationary Foos unit. A central lubricating oil system furnishes oil to every bearing in the engine under pressure. Special attention has been given to the designing of valves and valve gear and the whole valve and head arrangement is quite simple and accessible.

This engine has an operating speed range of 400 to 900 R.P.M. and the maker claims complete combustion at all speeds between these limits. The weight of the engine per horsepower ranges from 30 to 60 pounds, depending upon the materials used and the speed. Horsepower may be attained from this unit as low as 45 and as high as 475. This extreme flexibility makes it particularly convenient for mobile machinery power service and convenient for direct drive.

THREE-TON INDIANA TRUCK

The Indiana Truck Corp, Marion, Ind., announces its Model 126 three-ton chassis. The makers claim that the motor contains but one-half as many parts as most motors, and that the entire motor can be taken down in 60 minutes by a mechanic with a speed wrench. The maximum two-range multiple-speed transmission gives seven different speeds forward and two reverse, permitting either high speed or heavy pulling ability for bad roads.

The engine is 4-cylinder, 4½ inch bore, 5¾ inch stroke. Oiling is by full force system to main and connecting rod bearings and timing gears. A gear pump submerged in oil reservoir delivers oil at 15 pounds per square inch, while an oil filtrator prevents foreign substances reaching the bearings. The speeds have a range from .78:1 to 9.50:1. It is capable of a speed of 20 miles per hour with solid tires and 23 miles per hour with pneumatic. The wheel base is 162½ inches standard or 198½ long and 150½ short. The tread is 63 inches. It has a turning radius of 30 feet. With a body allowance of 1,500 pounds it carries a total maximum load of 7,500 pounds. The chassis weighs 7,400 pounds.

"SAVPAV" POURING KETTLE

The Thomas Fitzgerald Company, Fredonia, N. Y., manufactures a kettle for pouring hot asphalt or tar into joints of any kind of pavement or for repairing cracks, for which it is claimed that it keeps the material hot, eliminates waste of material, operates simply and enables a man to pour up to 1,000 gallons a day. It will hold 140 pounds of asphalt. A kerosene oil burner is placed in the bottom inside the outside receptacle, but it is intended that generally the asphalt will be preheated in a large asphalt kettle, and this burner is to keep the asphalt up to the required degree of heat. A small wheel is attached to the spout, which follows the joint or crack to be filled and thus directs the flow from the spout directly into the crack. For filling curb joints, an adjustable roller wheel at the back of the machine moves along the face of the curb and controls the position of the spout. The flow of material is controlled by a quick-acting throttle valve in the spout operated by a lever at the operator's hand. An extra squeegee attachment is supplied, if desired, for flushing the joints of brick pavements or seal coating asphaltic concrete pavements.

THE ROME GRADER

The Rome Manufacturing Company, Rome, New York, manufactures a grader which it claims was the first to use cut gears enclosed in oil tight cases, and lifts the blade higher than any other grader; also, that it has the only practical, properly designed steering gear on the market. Other features are the use of drop forgings, steel castings, holes in the frame drilled instead of punched, worm screws made from hammered forgings with cut teeth, and discs on wheels made from ¼-inch boiler plates, concaved to add strength. The disc wheel is said to act the same as the landside on a plow, holding the machine in position when ditching, and troweling instead of tearing and roughening the bank. Long roller bearings are used in all four wheels, mounted on a long spindle. The steering device is similar to that on automobiles. The combination steering and horse pole is made from pressed steel in two pieces, which telescope when used with an engine. The heel of the mold board can be raised to allow blades to be operated at a 50 degree angle, which permits using the mold board to slope outer banks without the use of a special attachment.

INDUSTRIAL NOTES

LITTLEFORD INSPECTION TOUR

The engineers of Littleford Brothers, Cincinnati, Ohio, in charge of road maintenance and construction equipment recently toured the states of Ohio, West Virginia, Pennsylvania, Maryland, Delaware, New Jersey, New York and Connecticut to study the Littleford heaters and other products in operation, offer suggestions for obtaining greater efficiency and learn of any changes that might improve them. No serious complaints were received from users, but a few very good suggestions for improvements of a minor nature were received and will be incorporated in new equipment.

BARBER GREENE COMPANY

The Barber Greene Company has opened a new office in Kansas City, Mo., at 2045 Main street, with E. H. Cooper, district manufacturer, in charge.

NEW CHAIN BELT MANAGER

F. C. Wilcox, for 18 years president of the Foote Concrete Machinery Company, has been made eastern manager of Rex paver sales of the Chain Belt Company with headquarters in New York City. The company is erecting a large engineering plant as an addition to the three groups now on their new 59-acre shop at the West Milwaukee works.

CRANE SERVICE ASSOCIATION

At a meeting in Cleveland at Hotel Statler, Nov. 11th and 12th, a national association named "Crane Service Association" was formed by unanimous vote of delegates sent by companies which offers crane service to their local communities. This service consists of crane work done by portable cranes on an hourly, tonnage or contract basis for companies which have insufficient crane work to afford owning such equipment. The meeting was arranged by representatives of the Crane Service Company of Newark, Motor Haulage Company of Minneapolis, Universal Crane Service Company of Springfield, Coffman Crane Service of Detroit, George Amish & Sons, Rochester, and was attended by 40 representatives of Crane Service Companies from cities reaching from Florida to Massachusetts and from New York to Minnesota. After discussions of advertising, business and technical nature, the following officers were elected: Peter Herkner, president; Charles O'Brien, vice-president; Q. J. Winsor, secretary-treasurer; and an executive committee consisting of R. Summers, C. Farris, Leo Coffman, S. Simon and W. H. Smith. The office of the association is at 914 Swetland Building, Cleveland.

This ARMCO culvert is still giving perfect service after 20 years of continuous use

Armco Quality your protection—

WHEN you buy an Armco culvert your money buys more than mere metal of a certain weight, more than a mere drainage opening of a stated size, more than a piece of pipe to meet a certain specification. Your money buys what it cannot buy in any other product—Armco quality backed by Armco reputation and by Armco's considerate service in your interest.

Quality of Metal

Armco culverts are made from Armco Ingot Iron —the only commercially pure culvert metal made. In twenty years of service under every known condition of climate and soil it has not been found necessary to add any other ingredient to the composition of this metal or to alter in any way its analysis.. Its superior rust resistive qualities have earned for it universal recognition as the Aristocrat of Culvert Materials.

Consistent Uniformity

The long life of Armco culverts is due not alone to the fact that the metal is pure; it is *uniformly* pure—the same composition of material year after year, installation after installation. In 95,454 analyses of Armco Ingot Iron, covering a period of seven years, the average variation in ferrous content was less than 2/10,000. This record of consistent uniformity is unequalled in the manufacture of iron and steel.

Ingot Iron

Proven Dependability

Armco culverts have been installed in every state in the Union and in every province of Canada continuously since 1907. Nearly 2,000,000 are now in use. The service rendered throughout the past twenty years by these culverts, many of them with repeated reinstallations in new locations, has supplied unmistakable proof of Armco dependability.

Quality Guarded by Nation-Wide Inspection

But Armco quality is due only in part to the happy discovery of a rust resistive iron. It is due as much to the jealous care with which the performance of Armco culverts has been watched for many years. Armco engineers are constantly in the field, examining, photographing, analyzing culverts. When a culvert gives less than its expected standard of service, these engineers ask why? Soils and ground waters are analyzed, and the abrasive qualities of the stream are studied. If the conditions noted are found to be of general occurrence then Armco engineers do not rest until they have found a solution.

These investigations have served the double purpose of maintaining the supremacy of Armco quality and of assuring the culvert buyer a type of structure exactly suited to his requirements.

ARMCO CULVERT ASSOCIATION
Middletown, Ohio

ARMCO CULVERTS

Consistent performance—because of consistent uniformity

CULVERTS FOR HIGHWAY

Under the title "Applying Culvert Simplicity to Highway Bridge Requirements," the Armco Culvert & Flume Mfrs. Assn. publish a bulletin which discusses various angles of culvert and bridge construction, with particular reference to the superior advantages of the former. There are many cases where the size of the stream would permit either type and then the responsibility of a choice falls directly upon the engineer. The advantages are discussed under the general heads of "Simplicity," "Capacity," "Safety," and "Cost."

REDUCTION IN MOTOR PRICES

The General Electric Company announces a reduction in prices on general service motors effective December 1 amounting to 5% on most lines and 10% on the commonly used sizes of squirrel cage induction motors. This brings the prices of the motors to within about 10% of those in 1914. It is announced that these reductions have been made possible by improved manufacturing processes and mass production.

ASPHALT MOTION PICTURES

The Texas Company, Asphalt Sales Department, New York City, offers to loan without charge two motion pictures, one showing sheet asphalt construction, the other asphalt penetration macadam. These show up-to-date methods of constructing these classes of pavements and are suitable for presentation before engineering bodies, chambers of commerce, students of highway building practice and similar bodies.

PORTLAND CEMENT ASSOCIATION PRESIDENT

The Portland Cement Association at its annual meeting November 15 to 17 elected G. S. Brown, president of the Alpha Portland Cement Company, as president; Col. E. M. Young, president of the Lehigh Portland Cement Co., and Robert B. Henderson, president of the Pacific Portland Cement Co., as vice-presidents. John W. Boardman, vice-president of the Huron Portland Cement Co., was re-elected treasurer. The new directors are L. R. Burch, vice-president of the Atlas Portland Cement Co.; Richard Harvey, chairman of the board of directors of the Pennsylvania-Dixie Portland Cement Corp.; Blaine S. Smith, vice-president of the Universal Portland Cement Co.; L. T. Sunderland, president of the Ash Grove Lime & Portland Cement Co., and C. E. Ulrickson, vice-president of the Trinity Portland Cement Co.

ARMCO CULVERT & FLUME MANUFACTURERS' ASSOCIATION

Effective January 1, 1927, the name of this association was changed to the Armco Culvert Association. This change of name does not imply any change of policy but the association will continue to devote its efforts to research in all matters relative to drainage and irrigation and to educational publicity for making this research known to those whom it will benefit. The association will have an exhibit at the annual road show, which will feature a model of a section of highway embankment through which a culvert is being jacked into place. Also sections of perforated corrugated iron pipe for subdrainage purposes, automatic drainage gates, and nested sections of standard highway culverts from 12 to 66 inches diameter will be shown.

CATERPILLAR TRACTOR COMPANY

The Caterpillar Tractor Company, Peoria, Ill., has just announced the opening of a district sales office and distributing warehouse at Albany, N. Y. The Thatcher Propeller Plant on Learned Street and the D. & H. Railroad has been leased for a term of years, is being completely overhauled, and will be ready for occupancy by January 1. Mr. H. M. Hale, District Sales Manager, who will be in charge, states that all field engineers and factory salesmen covering the New England and Eastern Atlantic States will operate from Albany hereafter.

BABBITT METAL DATA

The Hoyt Metal Company, St. Louis, has published a booklet with the above name which gives information concerning the selection of babbit metal, designing of babbitt bearings, and a list of the brands of bearings metals manufactured by this company.

ORNSTEIN CHLORINATION PATENT

Last May the Circuit Court of Appeals in New York sustained the U. S. District Court for the Eastern District of New York in its decision that the Ornstein patent was valid and the Paradon Engineering Co. was guilty of contributory infringement in manufacturing apparatus which used the process and directing that an accounting be taken to determine the damage suffered by the owners of the patent, the Electro Bleaching Gas Co. The Paradon Company applied to the Supreme Court of the United States for a writ of certiorari, but this was denied on November 23.

After a permanent injunction had been issued by the New York Circuit Court the Paradon Company equipped some of its apparatus previously sold with a pipe filled with iron which was designated a "bull pot." One of these was placed at Garden City, Long Island, and an action was brought against that village claiming that this was a continuation of the use of the Ornstein process, and the Circuit Court so found and directed that a preliminary injunction should issue restraining the village from continuing to use this apparatus, although it could use it for the purpose of making ferric chlorine or an iron salt.

BOONE & WEBSTER

The contracting firm of Boone & Webster has moved from 138 San Marco Avenue, St. Augustine, Florida, to Abstract Building, Palatka, Florida, where it will continue in highway and canal construction work.

NEW GARBAGE TREATMENT

Patents have been just issued to Dr. R. D. McLarin and C. G. Smith, superintendent of the Cleveland municipal garbage disposal works, for a new process of garbage treatment, which is generally described as a dehydrating treatment followed by grease extraction by naptha, for which it is claimed that 25% more grease is recovered than by former methods and the residue is secured in the form of a solid substance which can be ground for fertilizer.

ACTIVATED SLUDGE PROCESS

The General Filtration Co., Inc., Rochester, New York, has brought out another edition of its book entitled "The Activated Sludge Process of Sewage Treatment," in which it publishes a number of articles describing the process and installations where it is used, and gives data concerning the design and operation, and descriptions of filtros plates, which are used in most of the plants for applying air to the activated sludge tanks.

This book of 88 pages contains a number of articles, two of which appeared in *Public Works,* describing activated sludge plants in the United States, with excellent illustrations; also, articles on the theory, on diffuser plates, on activated sludge as a fertilizer and other information. While the company can not afford to distribute this book indiscriminately, it will be very glad to send it to any who have a proper interest in the subject.

NEW ORR CO. ENGINEER

R. S. Rankin, for some time with Pearse, Greeley & Hanson, consulting engineers of Chicago, became associated with the Sanitary Engineering Division of the Dorr Company on January 1st. He will make his headquarters at the New York office of this company.

SULLIVAN CHANNELERS

The Sullivan Machinery Company, Chicago, announces that the channeler business of the company has been sold outright to the New Albany Machine Manufacturing Co., of New Albany, Ind. All completed machines, stocks, patent drawings, tools, etc. have been turned over to them and orders for spare parts and new machines should be addressed to them.

THE GALION EXHIBIT

The Galion Iron Works & Mfg. Co., Galion, O., will exhibit at the Road Show, in spaces W9 and W10, the Master 10-ton motor roller, the Little Master, and the new leaning wheel grader.

The International Harvester Co. will show a 10-ton and a 5-ton Galion International roller and a Galion International E-Z Lift motor grader.

CHAIN BELT EXHIBIT

The Chain Belt Co., Milwaukee, will exhibit in space No. 1, main floor, the 1927 Rex paver, in which have been incorporated several new features which are claimed to be distinct ad-

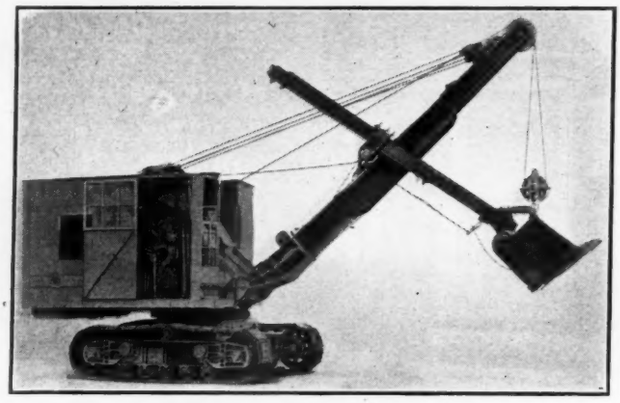
vances in design and operation of road pavers. There will also be shown two new Rex mixers which will be displayed in space No. 1 and NCB 19.

GOOD ROADS EXHIBIT

The Good Roads Co., Philadelphia, will show a new type of mechanical stone spreader known as the Goroco spreader—an independent unit attachable to any make of truck, which furnishes its own power and saves 90% of hand labor cost.

KEYSTONE DRILLER COMPANY'S EXHIBIT

The Keystone Driller Company, Chicago, will be in the same space at the Road Show as last year, where it will show the latest Model 4 Keystone excavator. A number of improvements have been made since last year, including the substitution of roller bearings at various points. Keystone Pull-stroke ditcher buckets of various sizes and latest designs will be exhibited, as well as the standard ⅝ yard skimmer bucket, which has been greatly improved. The exhibit will be in charge of the Chicago office, C. W. Holmes, manager.



KOEHRING GASOLINE SHOVEL

GARFORD TRUCKS AT ROAD SHOW

The Garford Truck Co., Lima, Ohio, will exhibit at the Road Show, Space A 5, a new Model 30, 1-½ to 2-ton truck, 122½-inch wheel base, on which is mounted Superior gravity 1½ cubic yard dump body; also a new Model 30, 1½ to 2-ton truck, with 144-inch wheel base on which is mounted a Heil standard hoist and 1½-cubic yard dump body.

OSGOOD COMPANY'S EXHIBIT

The Osgood Co., Marion, O., will exhibit at Booth 29 a 1¼ yard heavy duty gas crane, equipped with a structural boom of the lattice bow type. The new all-enclosed gear drive truck developed by the Osgood Company during the past year will be shown for the first time under this machine.

SULLIVAN EXHIBIT AT ROAD SHOW

The Sullivan Machinery Company, Chicago, has its road show headquarters at Booth No. W-1. Here will be shown a W K-314 V or angle type compresser on steel wheels; also, a WK-322 electric motor driven machine of 106 cubic feet capacity. During the exhibit this machine will supply air for other Sullivan equipment such as rotator hammer drills, concrete breakers and spaders. There will be also shown a Turbinair hoist, a contractors' drill sharpener, etc. Additional portable compressor units will be shown in the Wilson Building, consisting of a 310 foot WK-314 angle type balanced compressor driven by a Buda gasoline engine, a WK-312 Buda engine driven portable compressor on steel wheels and a WK-314 angle type machine.

KOEHRING ROAD SHOW EXHIBIT

The Koehring Company, Milwaukee, will exhibit at the Road Show, in Space 43, its 27 E paver and No. 1 gasoline shovel. The special features of the former are the grouping together of the high speed operating gears in a completely enclosed gear case, an exceptionally fast and accurate water supply permitting convenient and minute adjustment, easy steering mechanism, and self cleaning multiplanes.

The heavy duty gasoline shovel is equipped with a powerful cable crowd, the powerful dipper trip with finger-tip control, the powerful shock absorbing spring at the end of the boom which relieves the severe stresses on boom and dipper sticks, positive steering control and control of the boom angle from operator's position, and easy accessibility of parts.

NEW CATALOGS

(*Continued from page* 47)

tions, showing uses of the "Turbinair" steam and electric portable hoists.

SILENT GEARS

General Electric Company, Schenectady, New York. 28 page catalogue of Fabroil and Textolite gears, with description of construction, and tables and formulas of design.

ORTON GASOLINE SHOVEL

Orton Crane & Shovel Co., Chicago, Ill. 16 page bulletin No. 42 completely describing and illustrating the Orton Model "V" half-yard gasoline shovel. Illustrations, diagrams, descriptions and general specifications.

HAND BOOK OF SNOW REMOVAL

Good Roads Machinery Co., Kennett Square, Pa. 72 page hand book treating of snow fall; weather bureau stations; city, state and county organization for snow removal; equipment and procedure; drift prevention; private effort at snow removal; cost of removal, and a description of Good Roads snow plows. This will be shown and demonstrated by models at space N.C.B.-10.

INDIANA TRUCKS

Six pages of names of users of Indiana trucks and six of photographs showing fleets of such trucks owned by different corporations and municipal departments.

HARNISCHFEGER GASOLINE EXCAVATORS

Harnischfeger Sales Corporation, Milwaukee, Wis. 56 pages with 96 illustrations called Bulletin 61X giving complete description of the company's newest gasoline driven excavators, the all cast steel line.

ELECTRIC OPERATION OF VALVES

Coffin Valve Company, Neponset, Mass. 18 page pamplet describing the Kelty motor drive unit as applied to operating valves electrically rather than manually.

THE TAG CODEX

C. J. Tagliabue Mfg. Co., Brooklyn, New York. A 48 page illustrated catalogue of industrial thermometers of all types of construction and mountings.

HEAVY DUTY PAVERS

Koehring Company, Milwaukee, Wis. Catalogue No. 25, 48 pages, with descriptions, illustrations and specifications of all of the details of this company's latest type of pavers.

AUTOMATIC WELDING HEAD

General Electric Company, Schenectady, N. Y. Four-page folder describing the G. E. Automatic Welding Head and control, with automatic electro feeding device.

PROGRESS IN SANITATION

The Sanitation Corporation, New York City. A most artistic 32 page book showing, by photographs and descriptions, the work done by this corporation in connection with drainage, treatment of sewage and trade waste, purification of water and in other sanitary lines.

CLETRAC SNOW REMOVAL

Cleveland Tractor Company, Cleveland, Ohio. Large folder describing and illustrating use of Cletrac tractors for snow plowing.

ARC WELDING

Lincoln Electric Co., Cleveland, Ohio. Comprehensive treatment in 160-page text book of arc welding in general production manufacturing. More than 200 illustrations, diagrams, and charts.

McWANE PIPE MAP

McWane Cast Iron Pipe Co., Birmingham, Ala. Four page folder with two page map showing by dots the locations of users of McWane precalked joint pipe throughout the United States, as of November 15th, 1926.